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MARATHON DAM STORES DOMESTIC WATER FOR ATHENS, GREECE

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JANUARY 1933

Before the Battle of Waterloo and Napoleon's exile, the cast iron pipe shown below was installed in London's water supply system. It is still in use after 120 years of constant service.

Laid before Waterloo and still serving London

Officials of the Metropolitan Water Board of London recently uncovered for inspection an old cast iron pipe line in the original water distribution system of the city, known as the "New River Company," built by Sir Hugh Myddleton in 1613.

This old cast iron main was laid between 1810 and 1812 to replace wooden and stone pipe. It has been in constant service since the reign of George III, before the Battle of Waterloo and Napoleon's exile. When uncovered to the light of day for the first time in 120 years, the line was found to be "as tight as new." The trench was refilled. The pipe continues to carry on.

Cast iron pipe is internationally known as the longest-lived, most economical pipe for underground mains. In England, France and America cast iron mains laid over a century ago are still in service. The fact that municipal water works systems are almost invariably self-supporting is largely due to the long life and low maintenance cost of cast iron mains. Building water works projects will relieve unemployment and revive business *without increasing taxes or unbalancing budgets.*

* * * *

The reason for the long life of cast iron pipe is its effective resistance to rust. Cast iron is the one ferrous metal for water and gas mains, and for sewer construction, that will not disintegrate from rust. This characteristic makes cast iron pipe the most practicable for underground mains since rust will not destroy it.

* * * *

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Unretouched photograph of cast iron pipe laid in London between 1810 and 1812, and still in active service

CAST IRON PIPE

Among Our Writers

R. W. GAUSMANN was engaged in water supply work for New York City for many years. During the War, he served in France with the 303d Engineers, and later was commissioned a Lieutenant-Colonel. He joined Ulen & Company in 1925 and since 1927 has been in charge of all their activities in Greece, including the construction of the Athens Water Supply Works, the Water Distribution Company for Athens and Piraeus, and the construction of a $22,000,000 reclamation project in Macedonia.

DONALD M. BURMISTER received his engineering education at Columbia University after several years of practical experience, chiefly in irrigation work in the West. Since 1928 he has been connected with Columbia University, first as Testing Engineer in the Testing Laboratories, and then as Instructor in Civil Engineering.

ALBERT W. NEWCOMER, after four years of practical experience, entered the University of New Mexico, where he graduated in 1926. Since that date he has been connected with the engineering forces of the Middle Rio Grande Conservancy District, a project embracing drainage, irrigation, and flood control in the Middle Rio Grande Valley.

E. H. BURROUGHS has had broad experience in the field of dam design and construction. Graduating from the University of New Hampshire in 1910, he immediately became associated with the Ambursen Construction Company, Inc., of New York, of which he was made vice-president in 1922, in charge of engineering. Among the outstanding projects designed and constructed under his supervision is the well known Rodriguez Dam at Tia Juana, Mexico, the highest Ambursen-type dam yet built.

OMAR W. WHITE received his B.A. degree from the University of Montana in 1922. He then entered the U.S. Forest Service, and later joined the engineering staff of the U.S. Bureau of Public Roads. In 1925, he received his B.S. in Civil Engineering from the University of Wisconsin, where he taught Structural Engineering for one year. In 1931 he entered the service of the Highway Commission of Wisconsin.

A. I. RAISMAN has been on the engineering force of the City of New York in transportation work for more than 30 years, beginning as structural draftsman on the design of the first subway. He has passed through the various grades of Assistant Engineer, Division Engineer, and Chief Designing Engineer. His intimate knowledge of the complete development of Manhattan's rapid transit systems peculiarly fits him to write on the subject.

OREN REED, as a fellow of the American-Scandinavian Foundation, went in 1922–1923 to Norway to study hydro-electric developments. On his return he became Assistant Designing Engineer with the San Joaquin Light and Power Corporation, in Fresno, Calif., on hydro-electric design and construction. In 1929 he received a second fellowship to study the design and manufacture of electrical machinery in Sweden. Since May 1931 he has been Field Engineer for the Indiana Department of Conservation.

ORRIS BONNEY, after graduation from the University of Michigan in 1918, served eight months in the Sanitary Corps of the U.S. Army. From 1919 to 1923, he was employed in the City Engineer's Office, Detroit, Mich., and since 1923, he has been connected with the Division of Engineering of Columbus, Ohio. In both cities he has been engaged on the design and construction of sewerage works.

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Athens Builds Modern Water Works

Designed, Constructed, Financed, and Operated for the Greek Government by an American Firm

By R. W. Gausmann

Member American Society of Civil Engineers
General Manager, Ulen and Company, Athens, Greece

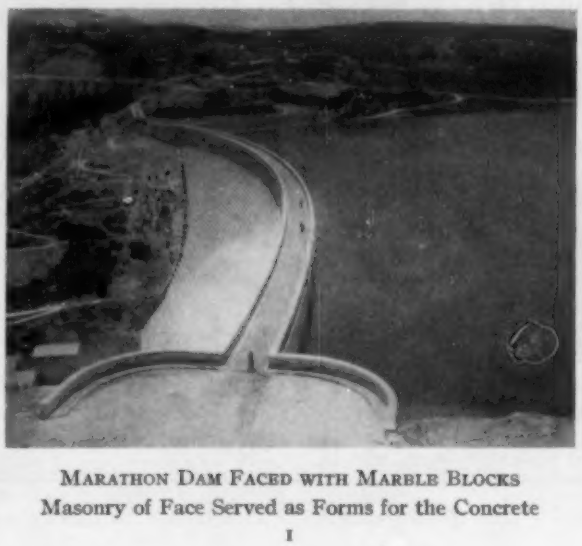
For eighteen centuries the remarkable aqueduct constructed during the reign of the Emperor Hadrian supplied Athens and the surrounding communities with water. But by 1925 the city and environs had grown to such an extent that this supply was completely inadequate. Situated in a hot, dry, barren valley, surrounded by naked limestone hills and mountains, its unpaved streets deep with dust that every wind raised into a white pall over the city, modern Athens had scarcely enough water to supply its 800,000 inhabitants with 10 qt daily for all purposes. Some of the best hotels had no water for bathing. Clearly the situation demanded a remedy. This article, prepared from the voluminous report presented to the Society by Colonel Gausmann and deposited in the Engineering Societies Library in New York, explains the steps taken by the Greek authorities in cooperation with Ulen and Company to provide Athens with an adequate water supply and a complete distribution system.

The "violet crowned" city of Athens, the home of the early philosophers and mathematicians, with a continuous history longer than that of any other modern municipality, is probably the most universally known city in the world. In art and architecture it set standards of excellence that have seldom, if ever, been equaled and have never been surpassed. But perhaps even more important than all this, it established a form of self-government that has served as the model for our great present-day governments.

While Athens excelled in spiritual progress, it was lacking in many of the essentials that our present, more material civilization demands. The most important of these was an abundant and readily available supply of potable water. It was not until nearly six centuries after the Golden Age of Pericles that an adequate water supply was established, and this construction, with only minor repairs, was the main supply of the citizens of Athens until 1931, a most astonishing record, which bears mute testimony to the skill, foresight, and integrity of those ancient workmen.

That the ancient Athenian, since the founding of his city on the sacred rock in 1259 B.C., clearly realized the lack of a sufficient water supply is noted from many ancient references. Thales considered water to be the first principle, and Aristophanes and Strabon noted the proverbial dryness of the Attic plain, while Solon, in 594 B.C., enacted severe laws regulating the delivery and consumption of water during a particularly dry period. But the energies of the ancient Greek were turned into more spiritual channels. Philosophy, literature, art, and politics were of greater importance, and so the meager water supply was obtained from local springs and wells. Somewhat later, underground collecting galleries were constructed through the water-bearing strata along the Illisus and on the slopes of Mount Hymettus.

It was the more practical minded Roman, with his inordinate love of bathing, who constructed the first adequate water supply for Athens during the time of the Emperor Hadrian, from 115 to 130 A.D., and his successor, Antonius Pius. This consists of the truly remarkable aqueduct that bears Hadrian's name. It collected the subterranean waters that flow from the base of Mounts Pentelikon and Parnes, and conveyed them to the reservoir on the slopes of Lykabettus. This aqueduct still serves the city of Athens. Some parts are masonry lined, with stone or brick and cement; others are unlined. The aqueduct is from 30 to 130 ft below the surface and was constructed from shafts spaced from 100 to 130 ft apart. Its capacity is about 6.6 mgd.



Marathon Dam Faced with Marble Blocks
Masonry of Face Served as Forms for the Concrete

During the Turkish occupation, when Athens dwindled to a small hamlet of some 5,000 inhabitants, the very existence of this aqueduct was unknown,

but in 1840, ten years after Greece became independent, it was rediscovered. Seven years later it was repaired and put back into service.

During the last century, Athens grew rapidly and the need for a larger supply became more and more urgent. Several repairs and extensions were made, and consideration was given to a new supply. Then came the Asia Minor disaster of 1922 and with it the influx of half a million refugees into the areas surrounding Athens and Piraeus, giving these cities and their environs a population of more than 800,000, with a combined water supply in dry years of 2.1 mgd, or 2.6 gal daily per capita. This was a very alarming situation. The unpaved streets of the rapidly growing city were covered with a thick layer of dust, which was raised by every breeze, so that Athens could be recognized a long way off by the dust cloud that hung over it.

To most Americans, the conditions in Athens were unimaginable. Most houses were supplied with one or more metal tanks with capacities up to 500 gal. If the pressure in the inadequate distribution system was sufficient, these tanks were placed on the roof and were filled by gravity. It was necessary in many parts of Athens to have two tanks, one at the ground level, to be filled from the main by gravity, and one on the roof, which was filled from the lower tank by a hand pump.

The city was divided into districts for distribution, and each subdivision was supplied with a limited quantity at more or less regular intervals, usually for one or two hours at intervals of four days. During this time house owners had to fill their receptacles. For the poorer houses, which had neither storage tanks nor connections to the mains, public taps or hydrants, known as fountains, were placed at convenient points about the city. There were more than 1,100 of these fountains, where long lines of women and boys often had to wait until one and two o'clock in the morning for their meager supply.

This condition was intolerable, and the agitation for a better water supply grew continually. Numerous studies were made, among them one by the firm of Ford, Bacon, and Davis in 1920, which proposed as an initial step an impounding reservoir at the junction of the Harada and Varnava rivers, 18 miles northeast of Athens, near Marathon, the famous battlefield of history. By 1924 plans had become sufficiently crystallized for the holding of an international competition by the government for the design of a new water supply, based on the storage structure now known as the Marathon Reservoir.

CONTRACTS AWARDED FOR FINANCING

In 1925 the Hellenic government ratified a contract specifying that a $10,000,000 bond issue be purchased jointly by the Bank of Athens and Ulen and Company,

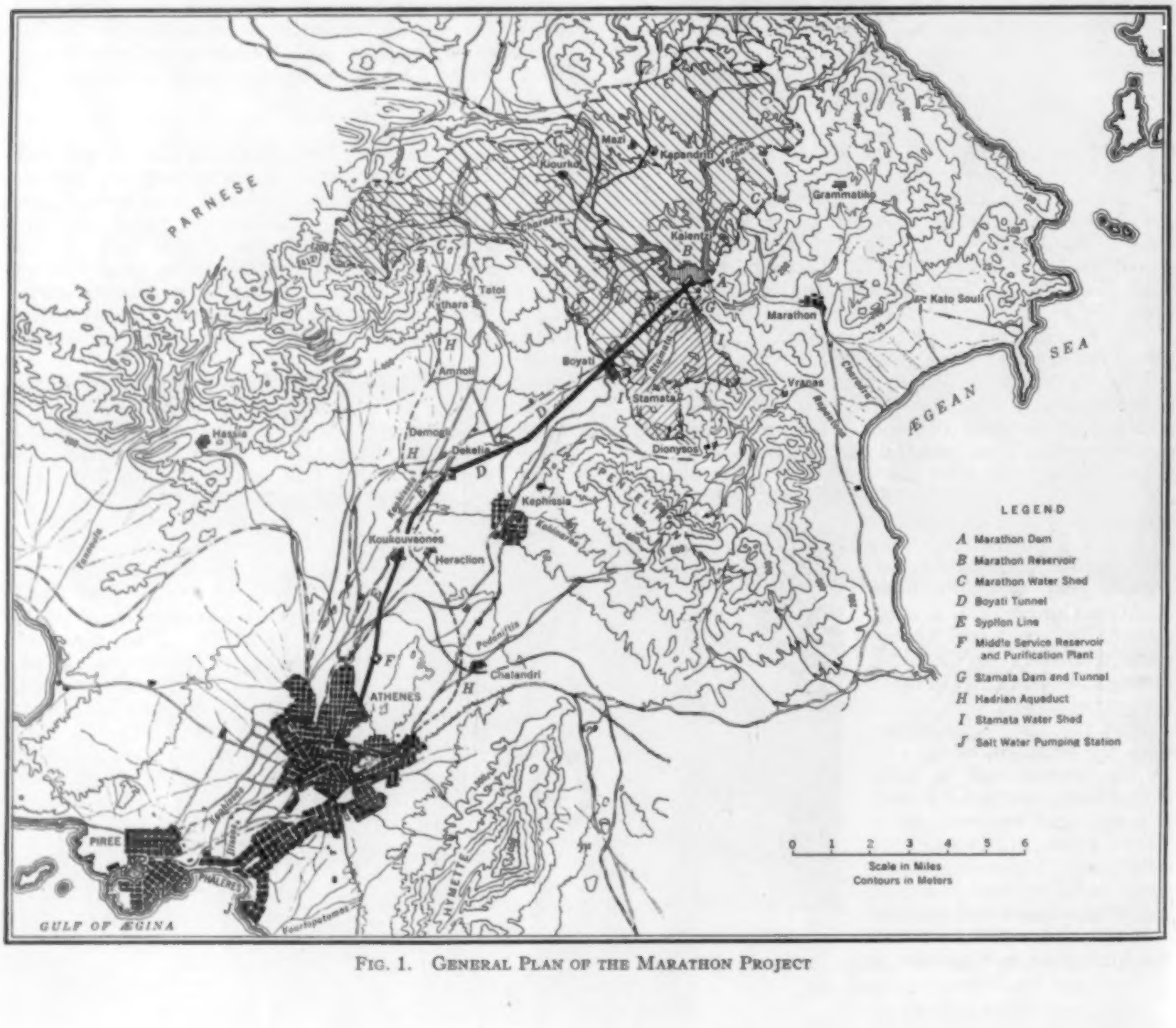


FIG. 1. GENERAL PLAN OF THE MARATHON PROJECT

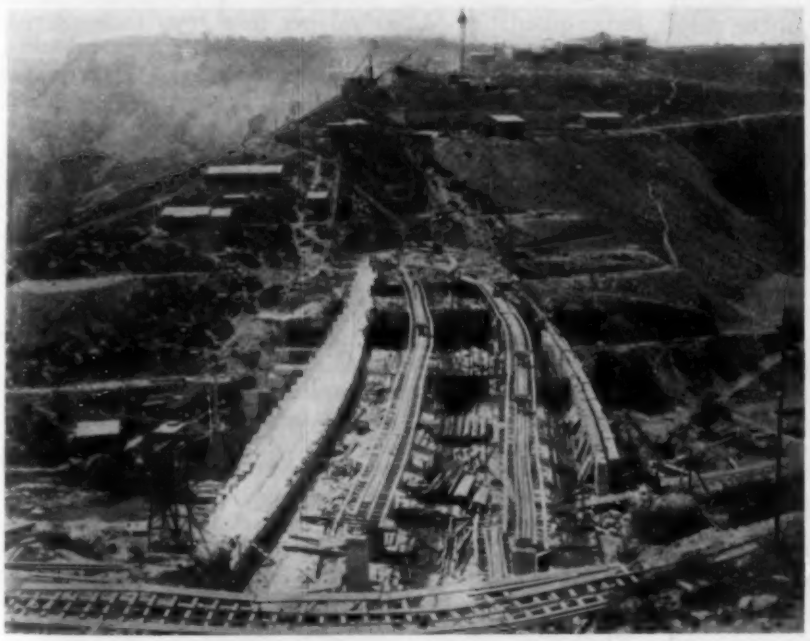
and that the latter be entrusted with the construction of the new works. Another contract between the same parties provided for $1,000,000 in bonds, the proceeds of which were to be used for the rehabilitation and extension of the Hadrian system and the construction of a salt-water street-sprinkling system for the city. The first contract provided for the operation of the new system by Ulen and Company for a period of 22 years after its completion; the second, for the immediate taking over and operation of the old system.

The old water works of Athens have been successfully operated since 1925. The provisional works were completed to the satisfaction of the government and accepted in 1926. On June 3, 1931, in celebration of the completion of the new works, the waters from the full artificial lake at Marathon gushed from a temporary fountain constructed near the ruins of the great temple of Zeus-Olympus, within sight of the Arch of Hadrian.

The project adopted by the government provided for the construction of the Marathon Reservoir, and "an aqueduct of approved size and material for conveying the water to the cities, reservoirs within or adjacent to the city, and a distribution system throughout the cities, together with such buildings, equipment, tools, and appliances as are necessary for continued operation."

In order to convey the water from the Marathon Reservoir to Athens, two separate projects were investigated. One of these, known as the "long route," contemplated an aqueduct that would follow the outer slopes of the mountains on the east, striking through the valley between the Hymettus and Pentelikon mountains, past the town of Chalandri, and thence to Athens. An alternative scheme, shown in Fig. 1, required the construction of a tunnel through the divide between Mounts Parnes and Pentelikon, until an elevation was reached where the water could be carried by other means to the city. The latter scheme was recommended and approved as being cheaper, safer, and more certain of execution.

SPILLWAY OF MARATHON DAM DISCHARGING 350 CU FT PER SEC
Its Full Capacity Is 18,000 Cu Ft per Sec with a Depth of $6^1/_2$ Ft at the Crest



THE DAM DURING CONSTRUCTION

From the south end of the tunnel, called the Boyiati Tunnel, it was proposed to construct a pipe line to the northern limits of the city and, at that point, a reservoir to contain at least a day's supply. This reservoir is the beginning of the distribution system, which extends throughout Athens, Piraeus, and environs. On August 30, 1926, the actual construction work was inaugurated by the firing of a round of holes at the north end of the Boyiati Tunnel.

MARATHON DAM OF MARBLE

The most spectacular part of the Marathon project is the dam, the only large marble-faced dam in the world. Its length is 935 ft, and it rises 177 ft above the river bed to an elevation of 745 ft above sea level. The width at the top is 15 ft and the widest part of the base is 158 ft. It is a full gravity section arched in plan (Fig. 2). The excavation required the removal of 74,000 cu yd of earth, and the dam contains 224,000 cu yd of masonry, approximately one-third of which is below the surface. The dam has been provided with a deep cut-off wall, with extensive and elaborate grouting in order to consolidate and render impervious the seamed substrata of greenish gray chlorite schist underneath. Full provision has been made to eliminate uplift by means of drainage galleries. In addition, provision was made in the design to withstand an uplift of two-thirds the head at the heel, diminishing uniformly to zero at the toe. Contraction joints were placed at intervals of about 80 ft throughout the length of the dam. A clay blanket 10 ft thick extends for a distance of 160 ft from the upstream toe. During construction, the ordinary flow of the streams was

carried through pipes, and later through a gallery left in the dam.

The first concrete was placed in the dam in October 1927, and the last exactly two years later. The concrete was made from marble obtained in the large quarry opened up near the south end of the dam. This material, finely crushed, was also used in place of sand. Thus it is truly a marble dam. A small quantity (from 3 to 8 per cent) of Santorin earth, a volcanic ash obtained from a nearby island, was added to the concrete to make it more nearly impervious and to reduce the heat of setting. The lower part of the upstream face was rendered stronger and more impervious by using 1.33 bbl of cement per cu yd. The concrete in most of the remainder of the upstream face contained 1.22 bbl of cement per cu yd, and that in the remainder of the dam above the surface had 1.0 bbl per cu yd.

COMPLETED BOYIATI TUNNEL, 8.4 MILES LONG
Normal Section in the Background

A spillway 328 ft long has been provided to take care of the overflow. The reservoir formed by the dam contains 33,200 acre-ft of water in an area of 600 acres. In places it is over 165 ft deep. Before flooding, all trees, bushes, and roots were removed, but no attempt was made to strip the area.

To prevent the shallow waters from becoming a breeding place for the anopheles, or malarial mosquito, a small number of gambusia, little fish that eat the mosquito larvae, were placed in the lake. These have now multiplied into the millions, and mosquitoes have thus been practically eliminated.

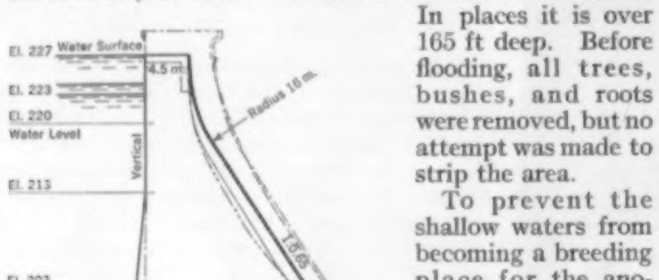


FIG. 2. MAXIMUM CROSS SECTION OF THE MARATHON DAM
As Compared with Profiles of Other Gravity Dams

About one-half mile below the Marathon Dam, the Stamata Creek joins the Haradra River. The waters of this creek have been turned into the Marathon Reservoir by the construction of a small, marble-faced diversion dam and a tunnel 3,350 ft long. By this means, the area of the watershed and the consequent supply have been increased by approximately 10 per cent at a relatively low cost.

EIGHT-MILE BOYIATI TUNNEL PRESENTS PROBLEMS

The Boyiati Tunnel was started on August 30, 1926, and completed on February 9, 1931. Its purpose is to convey the water from the Marathon Reservoir to Chelidonou. This tunnel is 8.4 miles long and throughout practically its entire length is lined with precast concrete blocks. A horseshoe section was adopted, with dimensions inside the block lining generally 7.5 ft wide by 8.1 ft high. Approximately 140,000 cu yd of material were excavated from this tunnel.

A little more than 5 miles of the south end of this tunnel was in a hard, compact earth made up of alternate layers of clay and conglomerates. Except for a few short stretches, this material presented no great difficulty in driving. What is believed to be a world's record was established when 53.8 ft in this material were completely driven and lined in 24 hr. The north end of the tunnel penetrated various kinds of rock, mostly schist of varying color and hardness, and about 2,000 ft of marble.

LARGE QUANTITIES OF WATER UNDER PRESSURE ARE ENCOUNTERED

At a distance of a little over $2^1/_2$ miles from the north end, water under high pressure (270 lb per sq in.) and in large quantities (6,250 gal per min) was encountered. After repeated but unsuccessful attempts to progress, this heading was temporarily abandoned. A shaft was then sunk to the south, on the tunnel line, in earth but near the point where rock might be expected to be encountered. When this shaft reached tunnel grade, the tunnel was driven in a southerly direction until it encountered the section that had been driven from the south, after which driving was started toward the north. The object of this maneuver was to provide a free passage for the entrained water so that it could flow to Athens, where it could be utilized, and then to attack the water-bearing rock from the opposite side. But of even more importance was the consideration that by driving a higher section of tunnel, a safe means of escape was provided for the men, in case water was encountered in large quantities.

After a certain amount of water had been drawn off and the pressure had been reduced, driving was resumed on the north end. This time a small pilot heading was advanced. This was very strongly supported with 6-in. steel I-beams, having 3-in. planks bolted on each side, and set skin tight. Holes were drilled to a distance of 26 ft in advance of the heading, and the water was drawn off through these holes. This method was a success, and both tunnels were brought together without further difficulty. For facilitating drainage, the tunnel was driven on an ascending grade of 0.001 to an apex near the middle. This tunnel is of the smallest size that could be driven rapidly with modern methods. It is ample to carry any available quantity of water.

From the south end of the Boyiati Tunnel the water is conveyed to the northern limits of the city of Athens

by a small tunnel $1^1/_2$ miles long, 4.6 ft wide, and 5.25 ft high, which follows the hydraulic grade. Then comes a cast-iron pipe line, 36 in. in diameter, for a distance of 3.4 miles. This pipe line does not follow the hydraulic gradient, but takes a more or less direct route, following the uneven surface of the ground. Thus the greater part of it is under pressure, and for this reason it is termed a siphon.

It might be pointed out that this is the greatest difference between the water works designed and constructed by the Romans and those of the present day. When the Roman, in projecting his aqueduct, encountered a deep valley, he either constructed a bridge to carry the water across at the hydraulic grade, or followed this grade until it crossed the valley farther upstream and then carried the aqueduct back on the opposite side. It will be noted from the photograph that the new siphon line parallels such a bridge constructed by the Romans. It is generally considered that the Romans understood the principle of the inverted siphon but did not have the materials necessary to resist the pressure built up, as their pipes were of terra cotta or lead. The siphon is divided into sections by valves so that, in case of a break or leak, the broken part can be isolated for repair.

ENTIRELY NEW DISTRIBUTION SYSTEM REQUIRED TO SERVE ATHENS AND ENVIRONS

Both in Athens and Piraeus the old distribution systems were entirely inadequate for the new supply. The mains were too small and could not be extended. It was therefore necessary to disregard the old system and to design and build an entirely new one, which was designed to supply 26 gal per capita, plus a 40 per cent allowance for daily fluctuations. Judging from the experience of other Mediterranean cities of equal size, it was thought that this amount would be sufficient, although for an American city it would be considered very small.

To distribute the water from the Middle Service Reservoir to all the various streets in Athens, 533 miles of cast-iron pipe were required—more than 33,000 tons. There is a great difference in elevation in the various parts of the city, and to keep the water pressures at the taps within normal limits, the entire area was divided into four districts, depending on elevation. The high service area is supplied by a reservoir on the hill northeast of the Field of Mars, which is filled by electrically driven pumps. Only 8.5 per cent of the population, that above elevation 360 ft, is supplied by pumping. The middle service area lies between elevations 360 and 230 ft, and the low service area between 230 and 165 ft. Below 165 ft lies the low-low service area. Still another area is served by the old Hadrian Aqueduct system. Separate reservoirs supply Piraeus and the Phalerons.

On many of the principal streets of the city, distribution pipes (mostly 3 and 4 in. in diameter) have been placed on both sides of the street in order to facilitate the work of connecting the houses to the new system and to prevent tearing up of the streets. For the 55,000 house connections, flexible copper tubing was used. Each service is metered, generally with $^5/_8$-in. meters. At the height of the work, 2,700 men were employed. This is believed to be the largest single pipe-laying job ever undertaken.

PURIFICATION PLANT INSTALLED

The water stored in the Marathon Reservoir would be considered potable by all modern standards, except possibly for short periods after heavy rains, when the turbidity may run as high as 200 ppm. During the dry season the reservoir water is clear, and seldom does the turbidity rise above 5 ppm. But, like the Roman, the Athenian is prejudiced against drinking from any but an underground source. In order to overcome this prejudice against an open lake, the government officials

Siphon Crosses Podarades Valley Near an Ancient Roman Aqueduct

rightfully decided to install a purification plant so as to prevent the possibility of ever delivering either turbid or polluted water.

The filtration plant has a capacity of 15 mgd. It consists essentially of an aerating fountain, a chemical dosing plant, sedimentation basins, rapid sand filters, a wash-water recovery plant, and clear water storage. Either aluminum sulfate and lime, or soda may be used as a coagulant. Provision is made for chlorination, or rather chloramine (chlorine and ammonia) treatment both before and after filtration.

In 1926 a salt-water system was constructed for street sprinkling and similar uses, to conserve the fresh water formerly used for that purpose. The water is pumped from Phaleron Bay, through a 24-mile cast-iron main, to hydrants in various parts of the city. The use of salt water increased rapidly; during 1930 the maximum monthly consumption reached 20,500,000 gal, and the year's use totaled 120,000,000 gal.

COST OF WORKS

The entire works, including general expenses and fees, have cost about \$11,300,000. The total cost of the dam is about \$2,200,000; that of the tunnel, \$3,100,000; and that of the distribution system, \$4,300,000. The remainder has been spent for the Stamata works, the siphon, the reservoirs, and the purification plant. All the work executed under both the operation and the construction contracts was done under the full control of the Greek government. All plans and reports had to be approved by the government engineers, and their execution was supervised by competent government inspectors. All the material purchased was also subject to their control from the time of its purchase until its actual incorporation in the works.

During the peak of the operations there were nearly 5,000 men engaged on all the works, and the average force from 1927 to 1930 was approximately between 2,500 and 3,000. With the exception of the staff and certain specialists, who were Americans and who averaged about 20 in number, practically the entire force was Greek.

Stirrups for Reinforced Concrete Beams

Spacing from the Support End of the Beam Determined by Tabular Coefficients

By Donald M. Burmister

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DETERMINING the spacing of stirrups in reinforced concrete beams presents an intriguing problem. Each designer has his favorite method, which to him appears simple and effective. Some solve the problem graphically; others use diagrams or the slide rule; and still others employ tabulations. Mr. Burmister has developed a table of coefficients which, when applied to the length over which the shearing stresses must be taken care of by stirrups, will give their spacing measured from the point of support. His method has its advantages, and designers will be interested in critically examining his procedure and comparing it with their own.

DESIGN of the web reinforcing for beams involves selection of both the size and the spacing of the stirrups. A method has been developed that offers advantages of simplicity and directness. It contains nothing new in the way of design, but is an improvement in the procedure.

The 1924 report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete has been followed as to nomenclature, unit stresses, allowable spacings, distribution of shear in beams, and other items, with additions that are noted as they appear. This method of designing stirrups will be presented here for three conditions of loading.

LENGTH OF BEAM IN WHICH STIRRUPS ARE REQUIRED

Case 1, which is for uniform dead load and stationary live load, is shown in Fig. 1, in which the following terminology is used:

V' = total shear at end of beam, in pounds
L = length of beam, in inches
v = safe unit shearing stress in the concrete, without web reinforcement = $0.02 f_c'$
v' = actual unit shearing stress in the concrete at support, computed by the formula, $\dfrac{V}{bjd}$

The distance, X', in inches, in which stirrups are required, is determined by direct proportion, and expressed by the formula:

$$X' = \frac{L}{2}\left(1 - \frac{v}{v'}\right) \qquad [1a]$$

Case 2, which is for a uniform moving load, is shown in Fig. 2. According to the Joint Committee's recommendation, the shear at the center of the beam is taken as equal to one-fourth the end shear and is assumed to vary uniformly. The distance in which stirrups are required is then determined by the formula:

$$X' = \frac{2L}{3}\left(1 - \frac{v}{v'}\right) \qquad [1b]$$

REQUIRED AREA AND NUMBER OF STIRRUPS

The next step is to determine the total area of stirrups required. In the distance X', this is equal to NA_v, where N is the total number of stirrups in half the beam, and A_v is the cross-sectional area of two legs of a U-stirrup. The total shearing force to be carried by vertical stirrups in a length X' is equal to the average shearing stress, $\dfrac{v' - v}{2}$, multiplied by the area on which it acts, that is, a plane b inches wide and X' inches long, or $\dfrac{(v' - v)\ bX'}{2}$. This total shearing force must be carried by the total number of stirrups at a unit working stress of f_v. Hence the total cross-sectional area of the stirrups required is equal to:

$$NA_v = \frac{(v' - v)\ bX'}{2 f_v} \qquad [2]$$

The number of vertical stirrups required, if the spacing were uniform, would be X' divided by the allowable maximum spacing. This maximum spacing, according to the recommendation of the Joint Committee, is 0.45 d. Many building codes, among them that of New York, recommend 0.75 d as the maximum spacing for stirrups when the shear stress is less than $0.06 f_c'$, and half this amount when the shear stress is greater.

DETERMINING STIRRUP SPACING

The average spacing, according to the Joint Committee, would be approximately equal to $\dfrac{2X'}{d}$. The stirrup

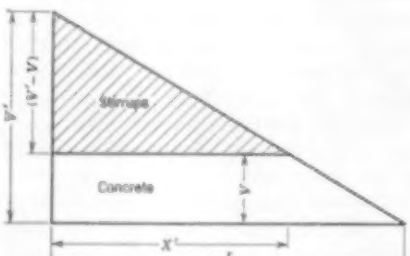


Fig. 1. Uniform Dead Load and Stationary Live Load

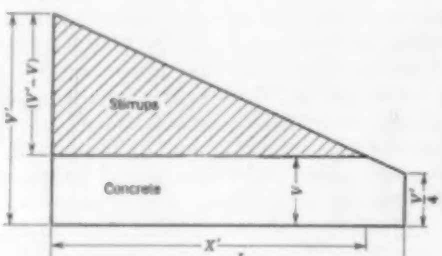


Fig. 2. Uniform Dead Load and Moving Live Load

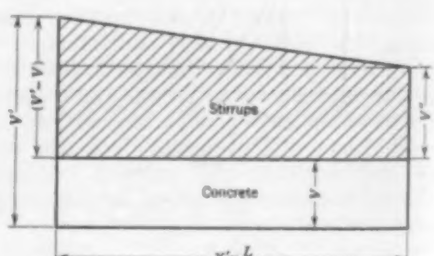


Fig. 3. Uniform Dead Load and Concentrated Live Load

Shear Diagrams for Cases 1, 2, and 3

TABLE I. COEFFICIENTS OF X' FOR DETERMINING THE SPACING OF STIRRUPS, MEASURED FROM THE SUPPORT

TOTAL NUMBER, N, OF STIRRUPS IN ONE-HALF THE BEAM

n*	2	3	4	5	6	7	8	9	10	11	12	13
1	.134	.089	.064	.050	.043	.037	.032	.028	.025	.023	.021	.019
2	.528	.292	.209	.163	.135	.114	.099	.087	.078	.070	.064	.059
3		.615	.387	.292	.237	.198	.171	.150	.134	.121	.110	.100
4			.667	.452	.355	.294	.250	.218	.194	.174	.158	.145
5				.701	.500	.403	.338	.293	.258	.231	.200	.191
6					.727	.537	.441	.376	.329	.293	.264	.240
7						.745	.567	.473	.408	.360	.323	.293
8							.757	.592	.500	.436	.387	.350
9								.777	.612	.523	.459	.412
10									.789	.630	.543	.482
11										.798	.646	.562
12											.807	.660
13												.815

n*	14	15	16	17	18	19	20	21	22	23	24	25
1	.018	.017	.016	.015	.015	.014	.013	.012	.012	.011	.010	.010
2	.055	.052	.047	.045	.044	.042	.038	.036	.035	.034	.032	.030
3	.094	.088	.082	.077	.073	.069	.065	.062	.058	.056	.054	.052
4	.134	.125	.115	.109	.103	.097	.093	.087	.084	.079	.076	.072
5	.176	.164	.152	.144	.135	.127	.119	.113	.108	.104	.099	.095
6	.220	.204	.189	.178	.167	.158	.149	.142	.134	.128	.122	.117
7	.268	.247	.229	.214	.202	.189	.179	.169	.161	.154	.146	.140
8	.318	.293	.270	.253	.237	.221	.209	.199	.187	.179	.171	.164
9	.373	.343	.315	.293	.274	.258	.242	.228	.216	.206	.196	.188
10	.433	.395	.362	.336	.313	.293	.275	.250	.246	.235	.223	.214
11	.499	.453	.414	.382	.355	.332	.311	.293	.277	.263	.250	.238
12	.577	.517	.469	.432	.399	.372	.348	.328	.308	.293	.278	.265
13	.672	.592	.532	.485	.448	.415	.387	.364	.343	.325	.307	.293
14	.822	.684	.604	.547	.500	.462	.429	.402	.378	.357	.338	.322
15		.828	.694	.616	.559	.513	.475	.444	.416	.393	.373	.352
16			.834	.703	.628	.571	.526	.488	.456	.429	.404	.382
17				.838	.712	.637	.582	.537	.500	.468	.441	.417
18					.843	.719	.646	.592	.547	.512	.479	.452
19						.847	.726	.655	.601	.557	.522	.490
20							.851	.733	.663	.610	.567	.532
21								.855	.739	.670	.618	.576
22									.858	.744	.677	.626
23										.861	.750	.684
24											.865	.755
25												.867

* n = the number of the stirrup, counting from the support.

spacing is not uniform but must be very much closer at the support than the average spacing because of the variation of shear in a uniformly loaded beam. A close approximation to the number of stirrups required, so that the spacing will not exceed the maximum allowable toward the center of the beam, is obtained by multiplying the average spacing by two-thirds. The minimum number of stirrups required in half the beam is therefore equal to:

$$N = \frac{3X'}{d} \text{ (maximum spacing according to Joint Committee)} \qquad [3a]$$

$$N = \frac{2X'}{d} \text{ (maximum spacing according to the proposed New York Building Code, when } v < 0.06 f_c') \qquad [3b]$$

$$N = \frac{4X'}{d} \text{ (maximum spacing according to the proposed New York Building Code, when } v > 0.06 f_c') \qquad [3c]$$

CALCULATING THE SPACING OF STIRRUPS

Utilizing the analytical method of subdividing the shear triangle, the following formula gives the distances from the support to a given stirrup:

$$S_n = X'\left(1 - \sqrt{\frac{2n-1}{2N}}\right) \qquad [4]$$

where S_n = distance from the support to the n th stirrup
n = number of the stirrup, numbered from the center of the beam
N = total number of stirrups in the length X'

A slide-rule method for solving $X'\sqrt{\frac{2n-1}{2N}}$, suggested by R. R. Martel, M. Am. Soc. C.E., was published in *Engineering News-Record*, for November 20, 1930, on page 822.

Formula 4 places the stirrup at the center of the area, which differs by a negligible amount from the center of gravity of the area. The distances measured from the support seem to have a more practical application to the problem of the actual laying out of the stirrups in the field than those measured from the center of the beam. Therefore Table I is computed from Formula 4, and gives the location of the stirrup in terms of X', measured and numbered from the support toward the center of the beam. The last coefficient in each column has been placed at the two-thirds point of its space, that is, at its center of gravity. A formula for placing the stirrup at the center of gravity of its area and a table computed therefrom, suggested by Robert S. Beard, were published in *Engineering News* for May 25, 1916, page 906. The difference is negligible, inasmuch as the spacings are usually rounded off.

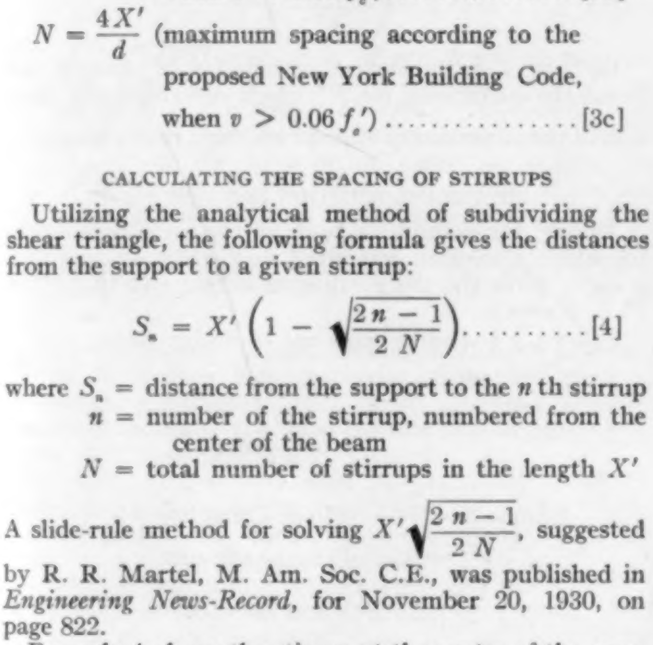


FIG. 4. ILLUSTRATING THE USE OF TABLE I TO SPACE A TYPICAL CASE OF EIGHT STIRRUPS

The coefficients for the selected number of stirrups are multiplied successively by the value of X'. If the maximum allowable spacing is exceeded, as many stirrups will be added toward the center of the beam as necessary, using a uniform spacing not greater than $0.45d$ (Joint Committee), or $0.75\,d$ if designed according to the proposed New York Building Code.

SEQUENCE OF PROCEDURE IN DESIGN

In designing the stirrups, the following steps are taken:

1. Solve for X', using Equation 1.

2. Find the total cross-sectional area of the stirrups required by Equation 2.

3. Divide this area by N, using Equation 3 as a guide to determine the number of stirrups. This gives the area of both legs of one U-stirrup.

4. Select the nearest size of bar from available tables of areas. The Joint Committee suggests as an approximate rule for determining the maximum size of stirrup that the diameter of the stirrup should not exceed one-fiftieth of the depth of the beam.

5. Readjust the number of stirrups for the size of bar selected.

6. The distances, measured from the support, are found most conveniently by the use of Table 1. The coefficients are taken from the column for the required number of stirrups and multiplied successively by X'. These spacings are then adjusted to the nearest half or whole inch, and if the maximum allowable spacing is exceeded at any point, stirrups with uniform spacing are added toward the center of the beam.

To illustrate this sequence of design, a solution for the following beam is presented, for which:

$b = 8$ in.; $d = 19$ in.; and span $= 12$ ft. Assume that $v' = 93$ lb per sq in., and $v = 40$ lb per sq in.

1. From Formula 1 b, $X' = 55$ in.

2. $NA_v = \dfrac{(93 - 40)\ 8 \times 55}{2 \times 16{,}000} = 0.729$ sq in.

3. $N = \dfrac{3 \times 55}{19} = 8.7$ (Try 9 stirrups.)

4. Area of one leg of one stirrup $= \dfrac{0.729}{2 \times 9} = 0.0404$ sq in. Use a $^1/_4$-in. round rod having an area of 0.049 sq in.

5. Adjusting, $N = \dfrac{0.729}{2 \times 0.049} = 7.4$. Use eight stirrups.

6. Spacing by Table 1, and keeping in mind the Joint Committee's maximum allowable spacing of 0.45 d ($0.45 \times 19 = 8.5$ in.), the following spacing will be determined (see Fig. 4):

Stirrup number n . .	1	2	3	4	5	6	7	8	9
Coefficient	.032	.099	.171	.250	.338	.441	.567	.757	
Multiplying by X' . .	1.76	5.45	9.4	13.8	18.6	24.3	31.2	41.7	
Adjusting spacing to the nearest half inch	1.5	5.5	9.5	13.5	18.5	24.0	31.0	39.5	48.0

Thus nine stirrups are used so as not to exceed the maximum allowable spacing.

DESIGN FOR CONCENTRATED LOADS

Case 3, in which the dead load is uniformly distributed and the live load is concentrated at the center, is shown in Fig. 3. The shear diagram for this case is trapezoidal, and the length, X', in which stirrups are required, is equal to:

$$X' = \frac{L}{2} \text{ in.} \qquad [1c]$$

Where the uniform load is small compared with the concentrated load, the variation in the spacing of stirrups is slight and the spacing required at the support may be used throughout. The first stirrup is of course placed at one-half of this spacing from the support. The maximum spacing is equal to $\dfrac{2X'}{d}$, according to the Joint Committee, or $\dfrac{4X'}{3d}$ if the New York Code is used, where X' is equal to $\dfrac{L}{2}$, or half the span.

The area of stirrup (two legs) required for this spacing at the support is equal to:

$$A_v = \frac{sb\,(v' - v)}{f_v} \qquad [5b]$$

The next step is to select the size of the bar and adjust the spacing for this size. Stirrups are then spaced uniformly throughout the beam. If, however, the uniform load is a considerable part of the total, the spacing of the stirrups should vary so as to represent equal areas of the trapezoidal shear diagram.

For Case 3, the total cross-sectional area of the stirrups required in one-half the beam is equal to:

$$NA_v = \frac{[(v' - v) + (v'' - v)]\ bX'}{2f_v} \qquad [6]$$

where v'', the shear stress at the center of the beam (Fig. 3), is larger than the allowable shear stress in the concrete, v, and where X' is now equal to $\dfrac{L}{2}$ in.

The number of stirrups will be slightly greater than for a uniform spacing, but not so large as for the triangular diagram. The number of stirrups will vary, as follows:

$$\text{From } N = \frac{2X'}{d} \text{ to } N = \frac{3X'}{d} \text{ (Joint Committee)}. \qquad [3a']$$

$$\text{or, from } N = \frac{4X'}{3d} \text{ to } N = \frac{2X'}{d}$$

(New York Building Code) . . . . [3b']

depending on the relative magnitude of v' and v''.

In order to determine the spacing of the stirrups in Case 3, an extra step, numbered 5 a in the sequence of design steps, is necessary to find the distance, X'', to a theoretical point where the shear stress would be equal to v, the safe unit shearing stress, and also the number of stirrups, N', that would be required in this length X''.

By proportion:

$$X'' = \frac{L}{2}\left(\frac{v' - v}{v' - v''}\right) \qquad [7]$$

$$\text{and } N' = \frac{N}{1 - \left(\dfrac{X'' - \dfrac{L}{2}}{X''}\right)^2} \qquad [8]$$

In Table I, in the vertical column for N' stirrups, are found the coefficients for X'' which determine the location of the N necessary stirrups required in the length $\dfrac{L}{2}$.

A TYPICAL SOLUTION FOR CASE 3

Taking, for example, a beam of the same dimensions for which a solution was given previously, assume that v and v' have the same values as before and that $v'' = 75$ lb per sq in.

Following the same sequence of design steps:

1. X' = half the span = 72 in.

2. $NA_v = \dfrac{[(93 - 40) + (75 - 40)]\ 8 \times 72}{2 \times 16{,}000} = 1.58$ sq in.

3. Assume $N = \dfrac{2.4X'}{d}$ (Joint Committee) $= \dfrac{2.4 \times 72}{19} = 9.1$. (Try 10 stirrups.)

4. Area $\dfrac{1.58}{2 \times 10} = 0.079$ sq in. Use ten $^5/_{16}$-in. stirrups, each leg having an area 0.077 sq in.

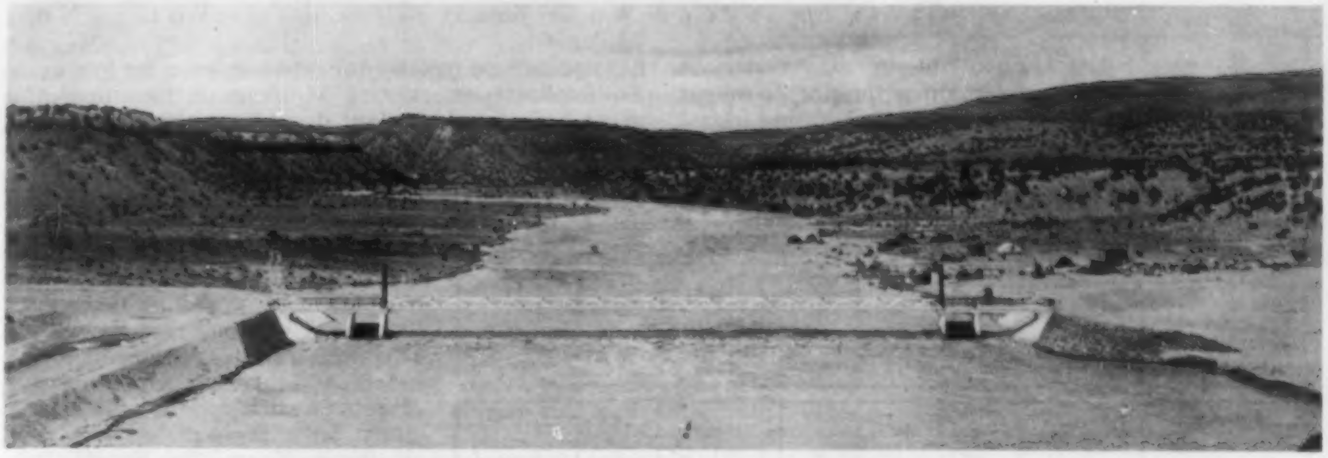
5. No adjustment is necessary. $N = 10$ stirrups.

5a. $X'' = 72\left(\dfrac{93 - 40}{93 - 75}\right) = 212$ in., by Equation 7

Then, by Equation 8, $N' = \dfrac{10}{1 - \left(\dfrac{170}{212}\right)^2} = 18$

6. Spacing, by Table I, in the vertical column headed 18, the coefficients for the location of the 10 stirrups are as follows:

Stirrup number . .	1	2	3	4	5	6	7	8	9	10
Coefficient	.015	.044	.073	.103	.135	.167	.202	.237	.274	.313
Multiplying by 212 and adjusting to nearest half inch	3.0	9.0	15.5	22.0	28.5	35.5	43.0	50.0	58.0	66.0



Rio Grande Discharging 16,000 Cu Ft per Sec Over the Cochiti Weir
Maximum Recorded Discharge for 40 Years Is 28,800 Cu Ft per Sec. Weir Was Designed for 50,000 Cu Ft per Sec

Profile for a Low Dam Determined by Models

Erosion Below the Cochiti Diversion Weir on the Rio Grande Effectively Controlled by Level Apron with Deflector Along Downstream Edge

By Albert W. Newcomer

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Assistant Engineer, Middle Rio Grande Conservancy District, Albuquerque, N.M.

Galileo once said, "I can learn more of the movement of Jupiter's satellites than I can of the flow of a stream of water." Hydraulic engineers since his day have had their difficulties too in predicting the behavior of water in motion. In New Mexico one low dam, the Cochiti Weir, has already been built to divert irrigation water from the Rio Grande, and other such structures are contemplated. Before constructing this dam, a carefully conducted series of tests on 1:10 models determined the most effective shape of the structure to prevent erosion of the stream bed below. Mr. Newcomer had charge of the tests and supervised the construction of the weir, which is in the form of an ogee section continued downstream, with a level slab terminating in a small deflecting sill along its downstream edge. That the design is efficient is indicated by the fact that 16,000 cu ft per sec already have been passed in safety over the structure, which was completed less than a year ago, in March 1932.

In planning the Cochiti Diversion Dam, near Santa Fe, N.M. (see Fig. 1), every effort was made to obtain a structure that would be safe, efficient, and economical. The dam consists of a concrete ogee weir, 8 ft high and 235 ft long at the crest, and a base slab 80 ft long, founded on heavy, well compacted gravel. At each end of the weir are a 12-ft sluiceway controlled by a radial gate, and diversion works consisting of concrete box conduits controlled by cast-iron slide gates.

Design Presents Problem

The flow of water under dams resting on porous foundations cannot be entirely stopped but it can be reduced to an amount that is almost negligible. By artificially increasing the distance of underground travel from headwater to tailwater, the velocity may be reduced to a point where there is practically no tendency to move even the smallest particle of the foundation material. The ratio of this length of underground travel to the difference in elevation of the water surface above and below the dam is called the percolation factor. In his book, *Practical Design of Irrigation Works* (1925), W. G. Bligh gives the following percolation factors for the materials named: fine sand and silt, 18; fine micaceous sand, 15; ordinary coarse sand, 12; gravel and sand, 9; and boulders, gravel, and sand, from 4 to 6. These factors have been developed mostly for dams across streams in India, where many failures occurred before the importance of the use of a proper percolation factor was recognized. A sufficiently large percolation factor may be secured by the use of cutoffs, sheet-piling, or substantially impervious aprons. For the Cochiti diversion site, with its heavy, well compacted gravel foundation, the impervious-apron type was adopted as it was believed to be more economical than any other. A percolation factor of 10 was used.

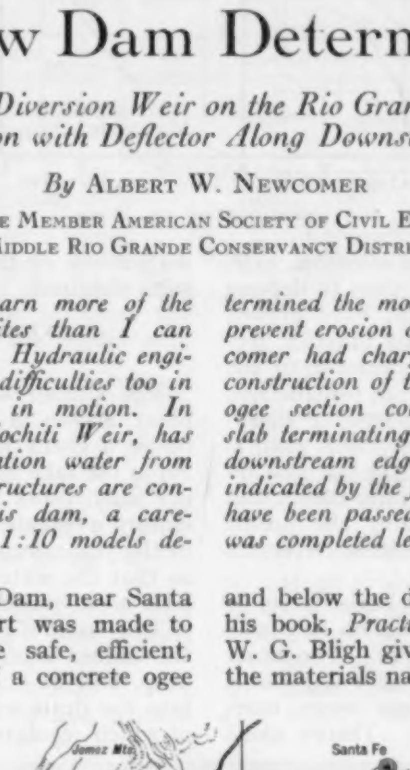


Fig. 1. Location Map

In designing the downstream apron, the possibility of an upward water pressure, or "uplift," was considered. Experiments show that the flow of water under dams has pressure characteristics similar to the flow of water

in pipes. Sound data are available in many textbooks to guide the designer in determining the proper weight of apron necessary to counteract these buoyant forces. In planning the Cochiti Dam, it was assumed that a full hydrostatic head of 8 ft. at the upstream edge of the base slab would be reduced to zero at the toe.

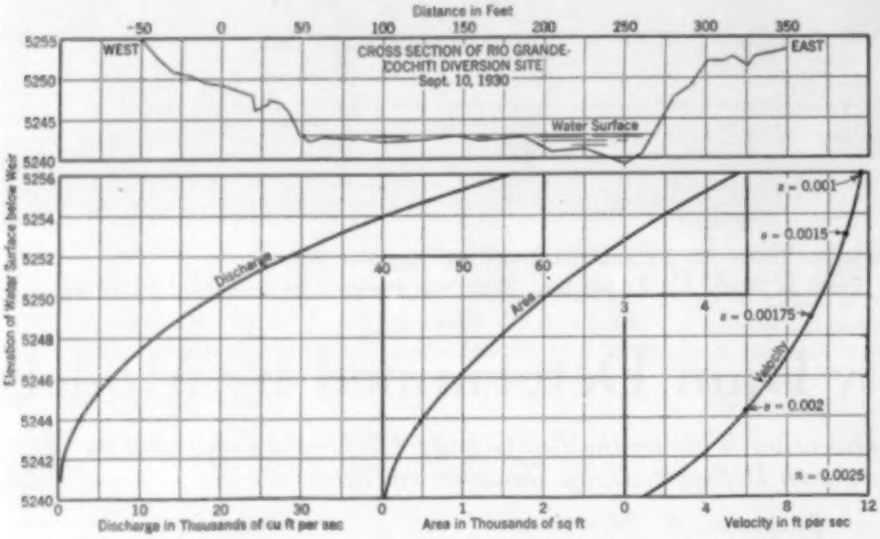


FIG. 2. CURVES OF AREA, VELOCITY, AND DISCHARGE AT THE WEIR

In selecting a suitable profile for an overflow weir, it has been necessary up to the present time to depend on empirical data or to copy dams that have proved satisfactory in use. Modern engineering practice recommends that the crest be made to conform to the path formed by water falling freely over an obstruction. The theoretical path of water passing over a sharp-crested weir in a vacuum is a parabola. This path is modified only slightly by the action of the air and by the shape of the crest. Many authors offer direct and suitably accurate methods of establishing the profile of overflow structures. For the Cochiti Diversion Dam, Etchevery's nappe was used.

On the other hand, the design of the bucket, toe, or apron for overflow weirs presents a problem not fully understood and very difficult to analyze. The exact path of the water over the apron is usually impossible to observe on existing structures. Here water may, and often does, travel in all directions. Theory alone has not sufficed to solve the problem, even for low weirs. To duplicate an existing structure is hazardous, for never have two important dams been required to meet the same conditions.

Recognizing the uncertainty of this feature of the design, the Middle Rio Grande Conservancy District undertook to determine, by means of a hydraulic experimental flume and models, the shape and elevation of apron that would be best suited to prevent erosion below the Cochiti Diversion Dam. Experiments of this nature, and the thorough comparison of results with conditions at actual dams, have been undertaken principally in Europe by Engels, Rehbock, Krey, and others. As a result of these experiments, it is now possible by means of laboratory tests to predict with confidence the exact conditions that will be obtained in full-sized structures. A vast store of information on model testing is available in the volume, *Hydraulic Laboratory Practice*, edited by the late John R. Freeman, Hon. M. Am. Soc. C.E. It describes many important laboratories, both in Europe and in the United States, together with many of the experiments undertaken and the results obtained.

EXPERIMENTAL PLANT AND MODELS CONSTRUCTED

The Conservancy District's hydraulic experimental plant, shown in a photograph, is situated immediately below a check in a drainage canal near Albuquerque. From the lake formed in the canal by this check, water normally flows laterally through a 30-in. pipe. By closing a wooden gate in this pipe, shown at the left in the photograph—the level of the lake may be raised so that the water will flow over a sharp-crested Cippoletti weir located at the upper end of the check. A stilling basin 6 ft wide and 8 ft long leads the water to the timber experimental flume. This is 3 ft wide, 3 ft deep, and 24 ft long. From here the water is wasted into the drain over an adjustable weir crest, the height of which regulates the elevation of the tailwater behind

HYDRAULIC EXPERIMENTAL PLANT OF THE MIDDLE RIO GRANDE CONSERVANCY DISTRICT
Timber Flume and Various Model Weirs Tested

the model. The water delivered to the model by the drain is clear. A flow of 14 cu ft per sec can be obtained with ease, and 20 cu ft per sec is available for short periods.

A plate-glass window in one side of the flume made it possible to observe the action of the water as it passed over the model and to take pictures from behind a black paper screen, shown in a photograph near the canal bank. The models were placed immediately behind this window, thus exposing to view the entire weir, the apron, and a part of the river bed immediately downstream. The model was set above the floor of the flume a distance corresponding to 10 ft in the river, and the bed of the flume below the model was then filled with fine sand to an elevation corresponding to that of the natural river bed. This sand was quickly and easily moved whenever any eroding currents were present below the model. A run of 15 min was usually sufficient for all scouring action to cease. In several tests where the flow was continued overnight, no appreciable changes in the profile of the river bed were noted.

The models consisted of a wooden form surmounted by a 2-in. layer of reinforced cement mortar, which was carefully shaped and troweled to the correct profile. For the model ratio used, small imperfections appeared to cause little disturbance in stream flow.

Model Ratios and Comparisons Used in the Experiments

For the model, a ratio of 1:10 was used, making all linear dimensions one-tenth those of the full-sized structure. The following relationships between the hydraulic properties in nature and in the model were used:

$$A:A_m = 100:1 \qquad [1]$$

$$V:V_m = \sqrt{10}:1 \qquad [2]$$

$$Q:Q_m = 10^{\frac{5}{2}}:1 \qquad [3]$$

in which A stands for area; V, for velocity; Q, for discharge; and the subscript m indicates values for the model.

A comparison of the hydraulic properties at the control section, near the crest of the 235-ft ogee weir, is given in Table I.

Curves for area and velocity, shown in Fig. 2, were drawn from a cross section of the Rio Grande channel

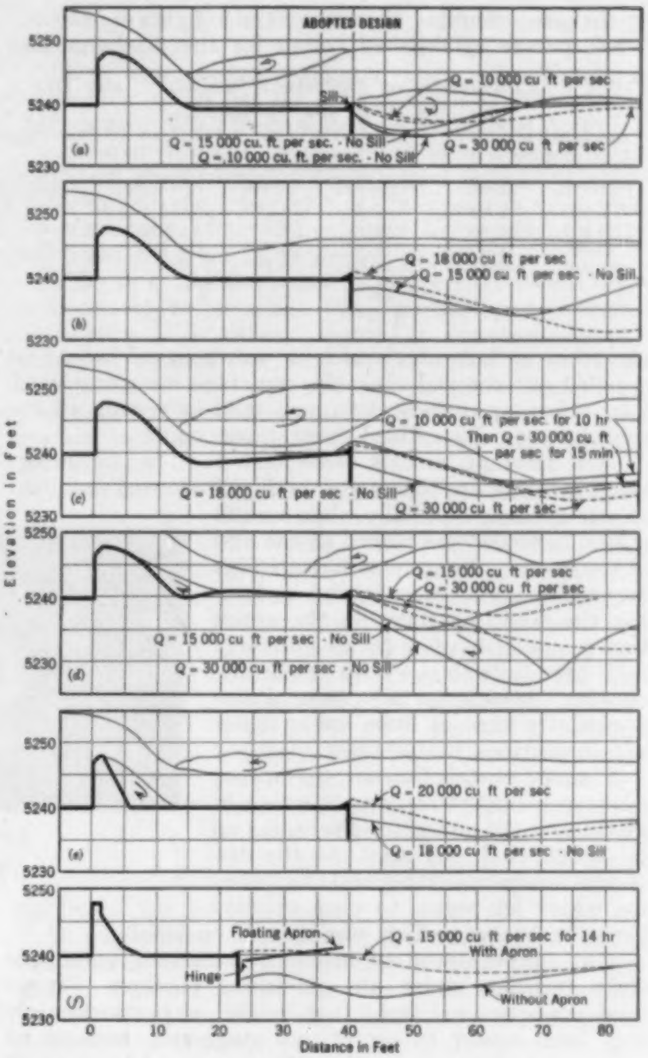
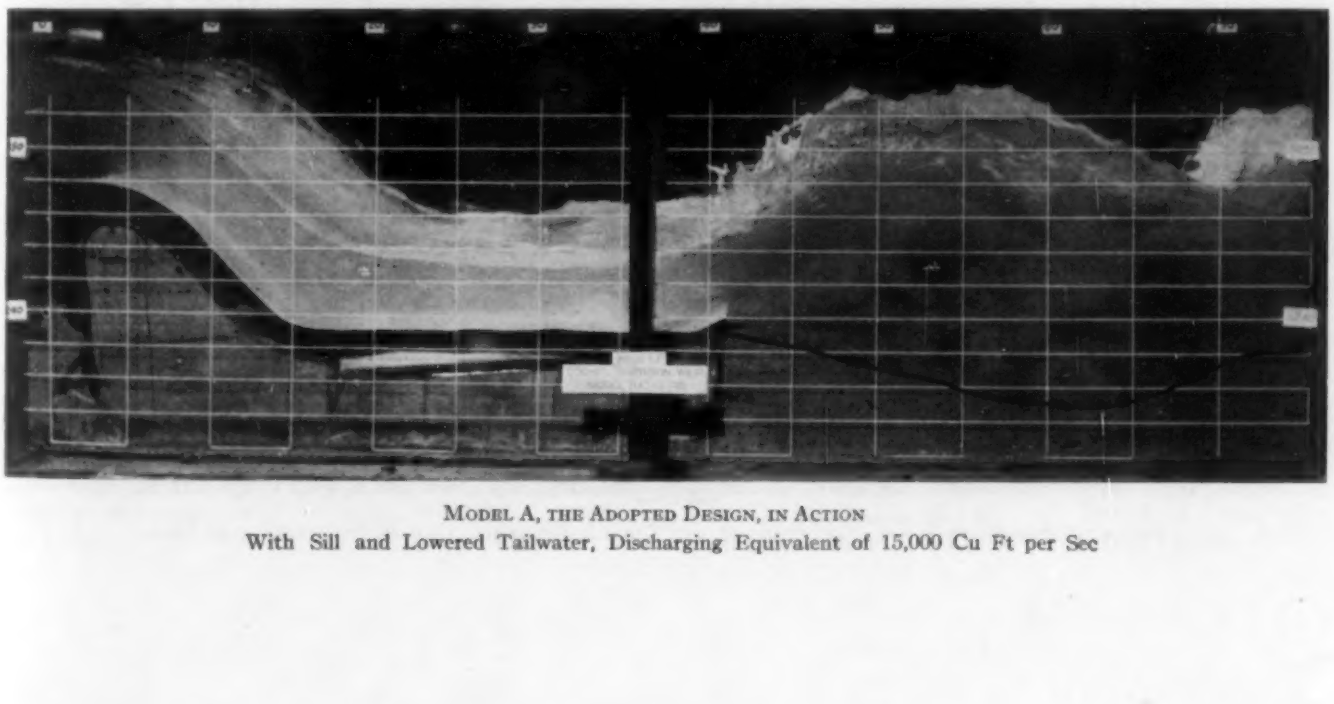


Fig. 3. Profiles of Models Tested with and Without Sill

(a) Model A, with Depressed Apron and Sill (Adopted)
(b) Model B, with Level Apron
(c) Model C, with Sloping Apron
(d) Model D, with Bucket-Shaped Apron
(e) Model E, with Special Crest
(f) Model F, with Special Crest and Floating Apron



Model A, the Adopted Design, in Action
With Sill and Lowered Tailwater, Discharging Equivalent of 15,000 Cu Ft per Sec

at the site, assuming a coefficient of roughness of 0.025. These curves established values for the discharge and

TABLE I. COMPARISON OF DISCHARGE, VELOCITY, AND DEPTH IN WEIR AND MODEL

Discharge in Cu Ft per Sec		Velocity in Ft per Sec		Depth at Crest, d_c, in Ft*	
Prototype	Model	Prototype	Model	Prototype	Model
5,000	2.02	8.8	2.78	2.4	0.24
15,000	6.06	12.7	4.02	5.0	0.50
35,000	14.1	16.8	5.32	8.8	0.88
50,000	20.2	19.0	6.00	11.2	1.12

* From the formula, $d_c = \sqrt[3]{\frac{Q^2}{g}}$.

elevation of tailwater which it was believed would be equaled or exceeded after the structure was completed. The tailwater surface elevations used in testing all the models were determined from these curves.

Ten different models were tested. The six whose cross sections are illustrated in Fig. 3 showed excellent characteristics, especially when a small sill or deflector was placed at the end of the apron. Transverse corrugations across the apron were helpful in forcing the jump to form on the apron under conditions of moderate discharge and low tailwater. With high discharges, however, the corrugations apparently were of little value under any conditions of tailwater.

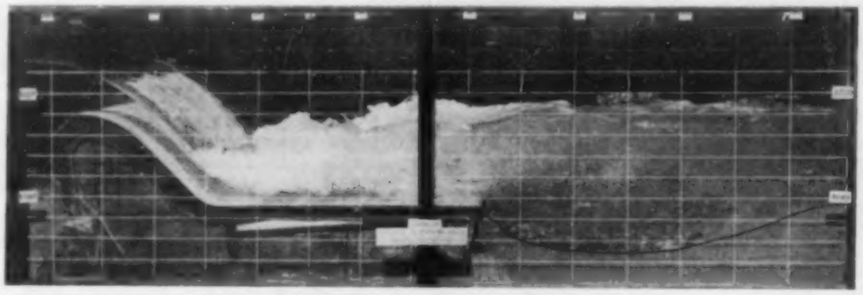
A sharp obstruction on the apron, such as a bucket lip, was effective in producing the jump for discharges up to 15,000 cu ft per sec. As the discharge was increased beyond this value, the water jet began to pass entirely over the bucket, which was then of no value.

The sloping apron of Model D indicated very poor characteristics under all conditions of flow. Jagged boulders between 1 and 2 ft in height, set approximately 5 ft from center to center and staggered, were of no apparent help in dissipating the energy. Moreover, it was considered that such baffles would be likely to catch debris and might produce the effect of a sloping apron or other objectionable conditions, and they were therefore abandoned.

Model E produced less rolling and smoother tailwater than any other model tested. But experience teaches that this type of weir causes rapid and severe erosion of the structure below the crest. For streams like the Rio Grande, which is normally muddy and often carries considerable sand and gravel, all the elements of an efficient grinding device are present. These objections more than offset the fine hydraulic properties of this model.

One run of long duration was made with Model F. On one side of the apron a floating apron made of timber was fastened. The other side was left exposed to simulate the condition that would obtain if one apron section were damaged or torn away. The test indicated that such a structure would be excellent where the floating apron was intact but quite unsatisfactory in the event that one section of it were missing.

In experiments of this nature, the surface elevation of tailwater is of great importance. At the beginning, these data were desired principally to simulate the true river conditions, but on lowering the tailwater in the flume it was found that the position and shape of the jump were far more dependent on the depth of tailwater on the apron than on any other factor. Under conditions of minimum tailwater, a change of 0.01 ft in elevation, corresponding to 0.1 ft in the prototype, was sufficient to cause the jump to form on or off the apron. The balance was very delicate. Whenever



MODEL A SHOWING SCOURING WITHOUT SILL
Discharging the Equivalent of 10,000 Cu Ft per Sec

the tailwater was lowered to this critical point and the jump permitted to leave the apron, it was difficult to cause its return except by raising the elevation of tailwater.

In view of the fact that this condition of insufficient depth of pool might obtain after the dam was completed—a condition which would then be difficult to remedy—it was deemed advisable to lower the elevation of the downstream apron 1 ft, as in Model A. This precaution was taken as a direct result of observing the action of water in the hydraulic flume.

A minimum depth of 2 ft of tailwater was required to keep the jump on the apron. Expressed in elevation, the lowest elevation at which the tailwater should stand was found to be 5,241 for Model A, the adopted design, or 5,242 for any of the other models tested.

The actual elevation of the water surface in the river on September 10, 1930, was 5,242.8; that on September 8, 1931, was 5,243.0. These were both under typical

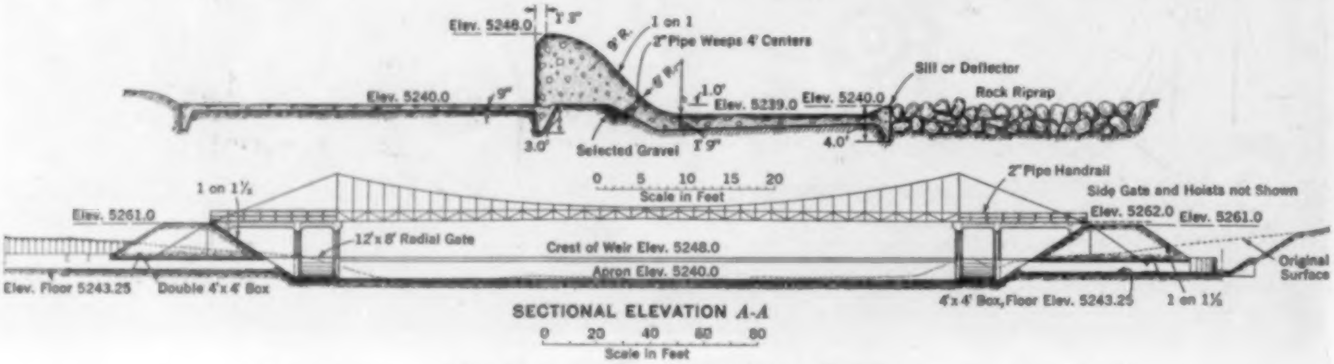
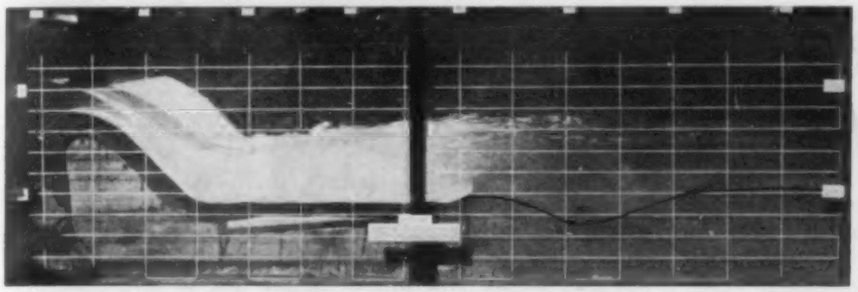


FIG. 4. CROSS SECTION AND ELEVATION OF THE COCHITI DIVERSION DAM AS CONSTRUCTED IN 1932

conditions of low water, the discharge undoubtedly being less than 1,000 cu ft per sec. The experiments indicated therefore that an average permanent scour of 2 ft in the original river bed might take place before there would be any tendency for the jump to leave the apron of the adopted design.

Sills, or deflectors, when located along the downstream edge of the apron, were of great value in keeping the sand packed against its lower edge. All models were tested with and without sills. The effect of sills apparently was to deflect the lower layers of water upward, causing an upstream movement of the water and sand immediately below the apron. In some cases this return flow was of pronounced magnitude and capable of moving even large-sized gravel from a point 5 ft below the toe of the model to the edge of the apron. This material was usually deposited on a 4:1 slope.

The sill was found to be useful in this respect even though the tailwater surface was lowered to the point where the jump occurred below the apron. It is believed that riprap placed immediately below the apron will not be displaced and will be only slightly eroded, since the jetting and scouring stream will be deflected upward and carried clear of the material immediately below the apron, especially at high discharges. The sill should not be higher than is necessary to produce a definite deflection of the lower water layers, for in the event of low tailwater and small discharges, the sill helps to form a second weir, causing a free overflow condition which is not desirable. Such a condition could obtain only with a badly scoured river bed below the dam. As the river bed at the Cochiti site is composed of large, firm gravel and shows no evidence of having ever been scoured materially, there seems little danger that the dam will be undermined from below.



Adopted Design, Model A, Showing Effect of Sill
Discharging the Equivalent of 5,000 Cu Ft per Sec

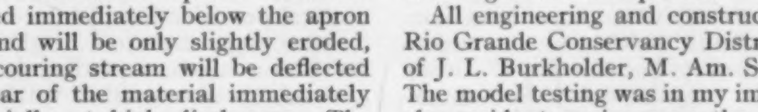
Sills 6, 9, 12, and 18 in. in height, both square and triangular in section, were tested. The slope of the triangular sills was varied from 1:1 to 4:1. A triangular sill 1 ft high, with a 2:1 upstream slope, was adopted.

These experiments indicated that a bucket-shaped or sloping apron has no outstanding advantage over a flat apron. With the adopted design, Model A (Fig. 4), the jump will occur on the apron at a lower tailwater elevation than with any other model tested. A sill, or deflector, at the lower end of the apron is very useful in preventing scour immediately below the dam and has some influence in producing the jump.

A depth of tailwater of 2 ft for very small discharges is necessary to force the jump on the apron. Baffles, corrugations, or other roughening accessories have a tendency to hold the jump on the apron under certain conditions of tailwater but are useless when the discharge is high. Adequate depth of tailwater is more certain to keep the jump on the apron than are such accessories.

There is no tendency to undermine the adopted design even though the jump does not form on the apron. With tailwater elevations as indicated by the hydraulic properties of the downstream river channel, it is believed that the jump will form on the apron under all rates of discharge up to 50,000 cu ft per sec. Since the maximum discharge recorded in 40 years was 28,800 cu ft per sec, the adopted design is believed to be satisfactory for any conditions of flow that are ever likely to occur. These experiments showed that the Cochiti Diversion Dam will not act as a drowned or submerged weir under any conditions of discharge that are expected.

All engineering and construction work of the Middle Rio Grande Conservancy District is under the direction of J. L. Burkholder, M. Am. Soc. C.E., Chief Engineer. The model testing was in my immediate charge and I was also resident engineer on the construction of the dam. Valuable assistance in outlining the testing work was given by L. N. Reeve, M. Am. Soc. C.E., Senior Engineer for the Stone and Webster Engineering Corporation.



Cochiti Diversion Works Discharging 6,000 Cu Ft per Sec in May 1932
Apron Terminates in a Deflecting Sill at the Downstream End of the Wing Wall Shown on the Opposite Bank

Before these experiments were made, it was believed that a bucket type of apron similar to Model C was best suited for the Cochiti site. However, observations at the flume, together with a comparison of the profile of the scour caused by the models tested, disclosed the fact that a flat apron such as Model B would serve equally well. Model B was then selected for more extensive examination, which resulted in adopting the slight modification in apron level incorporated in Model A, the type finally chosen.

Oklahoma City Dam, Oklahoma
Initial Construction, Which Was Later Raised 15 Ft to Increase the Reservoir Capacity 55 Per Cent

Initial and Final Dam Heights

Planned Construction Program Furnishes Economical Means of Increasing Storage Capacity

By E. H. Burroughs

Member American Society of Civil Engineers
Vice-President, Ambursen Construction Company, Inc., New York, N.Y.

FINANCING any water storage project is usually a difficult problem, but in these times of depression the difficulty is increased many fold. Mr. Burroughs indicates methods of enlarging the capacity of reservoirs by adding stop logs or gates to the crest of existing dams or by constructing the dams themselves in several stages, each increment in height to be built when required by increased demand for the storage, and when funds are available to cover its cost. Such a method reduces the ultimate carrying charges on a storage project and makes it possible to undertake the construction of extensions during periods of favorable markets. Thus successive increments of storage are provided at progressively less cost per acre-foot.

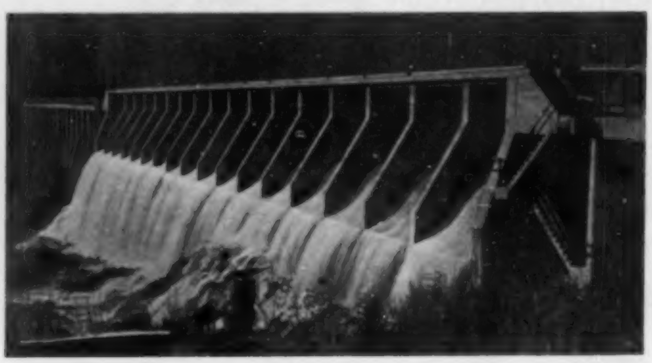
HERETOFORE nearly all dams have been constructed to fixed heights, which were assumed to be final and sufficient to provide for all future storage and water-power requirements. Recent experiences with many of these dams in service have shown that both greater storage and higher head than were originally anticipated are often subsequently required. These experiences justify the raising of numerous existing dams and the design of many future dams to provide for later increases in height where the topography permits and the drainage area can supply a larger amount of water for storage.

In a given case, it might not be economically feasible to construct an important dam to the maximum possible height in order to provide for emergency conditions or for the needs of a distant future, because it would impose a serious financial burden on the owner or taxpayer. It is possible, however, to make a farsighted and economical provision for all future storage requirements by constructing a dam to a height sufficient for present or short-term needs, according to a design that will be adequate to accommodate future additions.

The discomfort and tremendous economic losses caused by the recent failure of many municipal and industrial water supplies have emphasized the need of providing greater storage reserves than heretofore were considered essential. If these unpleasant and expensive experiences are to be avoided in future, water supplies must be adequately planned to meet such severe drought conditions as recently obtained, as well as to provide for the normal growth in demand.

RAISING EXISTING DAMS

Generally speaking, it may be said that most existing masonry dams can be adapted or reconstructed to provide some substantial measure of increased pondage



Jordan River Dam, Vancouver Island, British Columbia
Reservoir Capacity Increased 20 Per Cent by the Addition of 6-Ft Stop-Log Construction

without reduction of their safety factors, even though they were not originally designed for an increase in height. The three methods commonly used for this purpose are: adding flashboards to the spillway crest;

Table I. Reservoir Capacities Increased by Crest Regulation

Location	Type of Extension	Height, in Feet: Original	Height, in Feet: Final	Approximate Increased Reservoir Capacity In Per Cent
Jordan River, British Columbia	Stop logs	126	132	20
Coamo, Puerto Rico	Automatic crest gates	53	58	30
Mathis, Ga.	Automatic crest gates	88	94	35
Oklahoma City, Okla.	Tainter gates	50	65	55
Patillas, Puerto Rico	Automatic crest gates	6	11	200
Elizabeth, N.J.	Automatic crest gates	11	16	300
Benbow, Calif.	Automatic flashboards	18	30	300

adding crest gates, preferably automatic in operation; or adding to the initial construction a concrete structure that will both reinforce the existing dam and carry the additional water load. The use of flashboards is perhaps the commonest and cheapest way of obtaining a

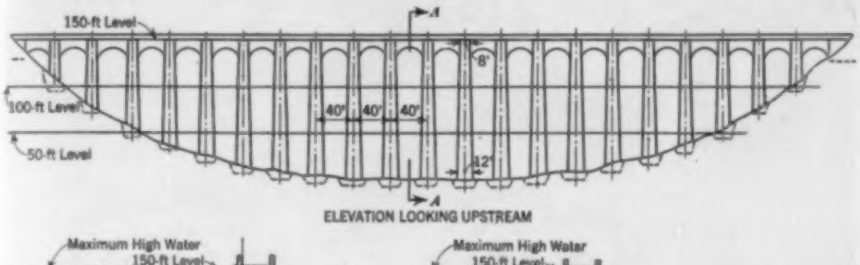


Fig. 1. Method of Raising a Hypothetical Dam
Either a Buttress or Gravity-Type Structure

very limited increase in reservoir capacity.

The installation of crest gates simply utilizes for permanent storage and head all or part of the available freeboard between the present level of the spillway crest and the maximum flood level. Hence, this increase is usually of greater proportion on a low dam than on a high one, but is always of great economy and immediate availability. After the completion of the initial structure, automatic crests permitting free spillway discharge at times of high water may be economically installed at any time when the power load or the domestic water demand requires it, whether they were originally contemplated or not, and these gates can be regu-

Oklahoma City Dam, Oklahoma
Reservoir Level Raised 15 Ft by Adding Tainter Gates

lated to give a very close control over the pond level. Examples of such installations from my recent experience are given in Table I.

Where the height of an existing gravity dam must be raised more than is permissible with automatic crests, downstream buttresses supporting an upstream water-bearing face may be used. Examples of this type of construction are the Assuan Dam in Egypt and the Trap Falls Dam at Bridgeport, Conn., for which data are given in Table II. Another method consists of joining to the downstream face an additional gravity section. The Lock Raven, at Baltimore, Md., the Nolichucky, at Greenville, Tenn., and the Browns Falls Dam at Browns Falls, N.Y., also shown in Table II, are good examples of this method.

Increased Height Gained by Extending Buttresses and Adding Deck

In the case of dams of the Ambursen type, the additional height is customarily provided by extending the original buttresses downstream and by adding the conventional flat-slab, water-bearing deck to whatever new crest height may be indicated. Examples of such construction are given in the lower half of Table II.

Recent experience indicates the wisdom of designing and building initially with an eye to future increase, particularly because such provision adds little to the financing cost of the original project, and in fact may greatly lighten the immediate burden.

Table II. Dams Raised by Adding to the Original Structure

Dam	Location	Height in Feet: Initial	Height in Feet: Final	Purpose	Remarks
Mass Concrete Dams:					
Trap Falls	Bridgeport, Conn.	49.0	60.0	Water supply	Raised with buttresses
Browns Falls	New York	23.0	61.0	Power	Designed to be raised
Nolichucky	Greenville, Tenn.	42.0	77.5	Power	Designed to be raised
Lock Raven	Baltimore, Md.	51.0	103.0	Water supply	Designed to be raised
Assuan	Egypt	76.0	118.5	Irrigation	Not designed to be raised
Dams of the Ambursen Type:					
Danville	Kentucky	14	18	Water supply	With an Ambursen extension
Utica	New York	30	40	Water supply	Designed to be raised
Boysen	Wyoming	40	50	Power	Designed to be raised
Mt. Union	Pennsylvania	50	64	Water supply	Designed to be raised
Bristol	New Hampshire	58	86	Power	Designed to be raised
Marfa	Texas	68	103	Irrigation	Designed to be raised

BRISTOL DAM, BRISTOL, NEW HAMPSHIRE
Above, Initial Construction, Passing a 12-Ft Flood; Right, with 28-Ft Extension Completed in 1932

The best economic results are obtained when the initial construction is properly planned in relation to the completed structure rather than when the reconstruction and height addition is a forced measure due to unexpected demand or to drought conditions.

The great economic saving that may be effected through designing dams to be later raised to meet increased requirements for storage or head may be seen by a study of Fig. 1. This example shows a design for a hypothetical dam to be used for a power development, to be first constructed to an initial height of 50 ft, sufficient to provide the cheapest possible initial development, and later raised to 100 ft and then to 150 ft through the addition of two 50-ft extensions. Alternate designs and estimates were prepared for all three heights for both a buttress-type and a gravity dam, for each of which a section is shown in Fig. 1. The procedure consists of adding a curved, inclined section, analyzed as a series of columns, to the downstream face of the initial construction. These columns are independently stable under full load conditions and are so designed that stress distribution in the completed structure will be only slightly influenced by the presence of the joints between the extensions.

In Table III the cost of each 50-ft extension is expressed as a percentage of the total cost of the completed structure. It is interesting to note that in this example the same percentages of cost apply approximately to both the Ambursen and the gravity types. In contrast to the diminishing cost of each increase in height, will be noted the increasing proportion of reservoir capacity (from Fig. 2) that is gained with each extension.

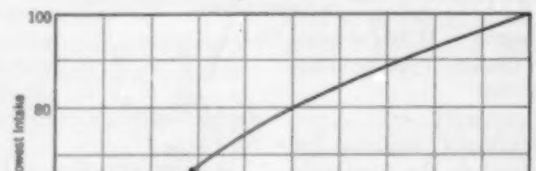


FIG. 2. RESERVOIR CAPACITY CURVE
Applied to the Dam in Fig. 1 to Obtain the Values Shown in Table III. Based on Average of Capacity Curves of Stony Gorge, Arrowrock, and Elephant Butte Projects of the Bureau of Reclamation

Cost savings depend largely on the intervals between the construction of each extension. The savings in interest alone on the cost of the deferred first and second exten-

TABLE III. RELATION BETWEEN COST OF INCREASING THE HEIGHT OF THE DAM SHOWN IN FIG. 1 AND THE RESULTING RESERVOIR CAPACITY

Height in Feet	Percentage of Final Cost	Percentage of Final Reservoir Capacity
Initial construction, 50 ft	16	5
First extension, to 100 ft	44	23
Final extension, to 150 ft	40	72
	100	100

sions, at 6 per cent per annum compounded, in seven years would total an amount that would entirely pay for the second extension. Accumulated compound interest on the cost of the third extension would pay for it in a further period of 14 years.

In summary, the most important of the economic benefits obtained by constructing dams that are designed for future increases in height is that taxpayers or stockholders are not required to assume a financial burden that rightfully belongs to posterity. Heavy financing charges may be avoided in the early stages of a development, when it is least able to carry this load. At the same time, farsighted provision can be made for the water supply that will be eventually required by future city growth and for periods of unusual shortage.

A second advantage is that extensions to the dam can be undertaken when the cost of labor and materials is low, or when seasonal depression makes them advantageous. A third advantage is that taxpayers will more readily vote for the smaller bond issue required for the initial construction of a dam designed to be raised than they will for the large bond issue that would be needed for the complete structure.

Mapping Montana's State Forests

Data on Timber Resources and Watershed Protection Simplify Administration of Public Land

By Omar W. White
Associate Member American Society of Civil Engineers
With Bridge Department, State Highway Commission, Madison, Wis.

An important first step in the conservation of natural resources is to find just what physical masses and economic potentialities are in question, so as to determine a logical sequence of administration. Facts are thus the prime requisite, and frequently the engineer is the man assigned to collect them. This was the program followed in the case of the state timber resources of Montana. How the first survey methods were finally developed is described succinctly by Mr. White. In each square mile a topographer and a timber cruiser followed eight parallel courses, largely by compass and eye. Since every point in the area was within 330 ft of some traverse, thorough information was thus gleaned as to topographic characteristics, amount and kind of cover, and economic possibilities.

In most of the states admitted to the Union during the nineteenth century, two sections out of each township were reserved from the public domain for school purposes at the time of admission. In Montana, Sections 16 and 36 were thus reserved. The state includes within its boundaries 18 National Forests and 6 Indian Reservations, with a total area of about 32,000 sq miles. Many of the "school sections" were included within the boundaries of these reservations.

In order to facilitate the administration of these lands, the state has pursued a policy of consolidation by exchange or by sale and purchase, so that at present it has about 203,000 acres of forest lands consolidated in seven blocks, as shown in Fig. 1. In addition, about 297,000 acres of scattered forest lands are yet to be consolidated. Of this total state forest area, 290,000 acres is merchantable timber, mainly in the seven State Forests, and the remainder is classified as open grassland, or cut-over, burned, or alpine land (the last valuable only as watershed protection).

In the summer of 1922, after the consolidation had been under way for some time, it was found desirable to map quite completely the consolidated areas and to obtain other data to assist in the efficient administration of these lands. It was my privilege to organize and direct these early operations. As this work involved some unusual problems in rapid examination, and as the solutions found might be applied to other projects, a discussion of it may be of value to the profession at large, whether or not the members have contact with forest engineering as such. The general methods used are familiar to all forest engineers, but some innovations were practiced, which may be of interest.

Nearly all the lands examined were in areas that had been surveyed by the General Land Office. On most of the sections, survey lines could be traced and one or more section corners could be definitely established.

After determining the areas to be covered, the first step was to obtain, from the General Land Office, copies of the original plats and field notes. This was particularly essential in the north and west tiers of sections in each township, into which any irregularity is normally thrown, and in sections containing meandered lakes and streams. From these plats and notes a fairly precise estimate was made of the distances to be traversed and the best direction to be taken in examining any particular section.

Parties Equipped for Timber Surveying

Each field crew consisted of two men, a "compassman" and a "cruiser." Briefly, their duties were divided between observation of the physical characteristics of the ground and those of the cover. The compassman was charged with the observation of topography, culture, stream data, and geological conditions and was equipped with a pocket compass, an "Abney" level, and a notebook. A request was made for a pocket aneroid barometer for each crew, but it was denied. This instrument has been effectively used on some subsequent work of this nature.

The cruiser was charged with the estimation of the timber stand and the notation of ground cover, grazing possibilities, and undergrowth. He was equipped with a notebook and a "Biltmore" stick. This latter may be described, for the benefit of the uninitiated, as a maple stick about a yard long graduated on the front side in such a manner that the observer, holding it tangent to a tree trunk at a distance of 27 in. from his eye, with the end on a line of sight tangent to one side of the

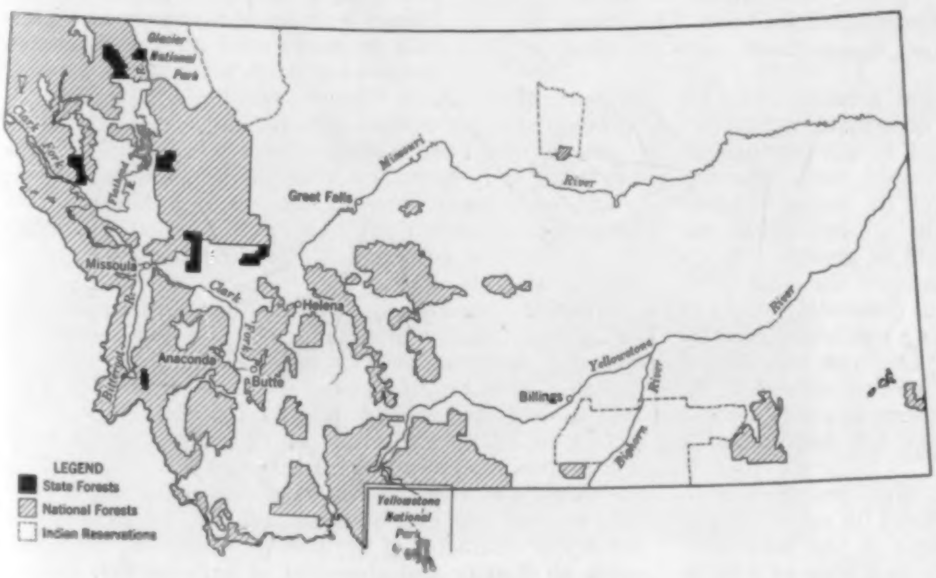


Fig. 1. Relative Size and Distribution of State Forest Preserves in Montana
These Include Large Areas, Mostly Along or Near the Continental Divide

tree, can read the diameter in inches on a line of sight tangent to the other side of the tree. The back of the stick has also an important use. It is so graduated that the observer, standing at a distance of one chain from the foot of the tree and holding the stick in a vertical position, can estimate in a similar manner the number of 16-ft logs that can be cut from the tree. After a few weeks of practice, the cruiser becomes able to judge

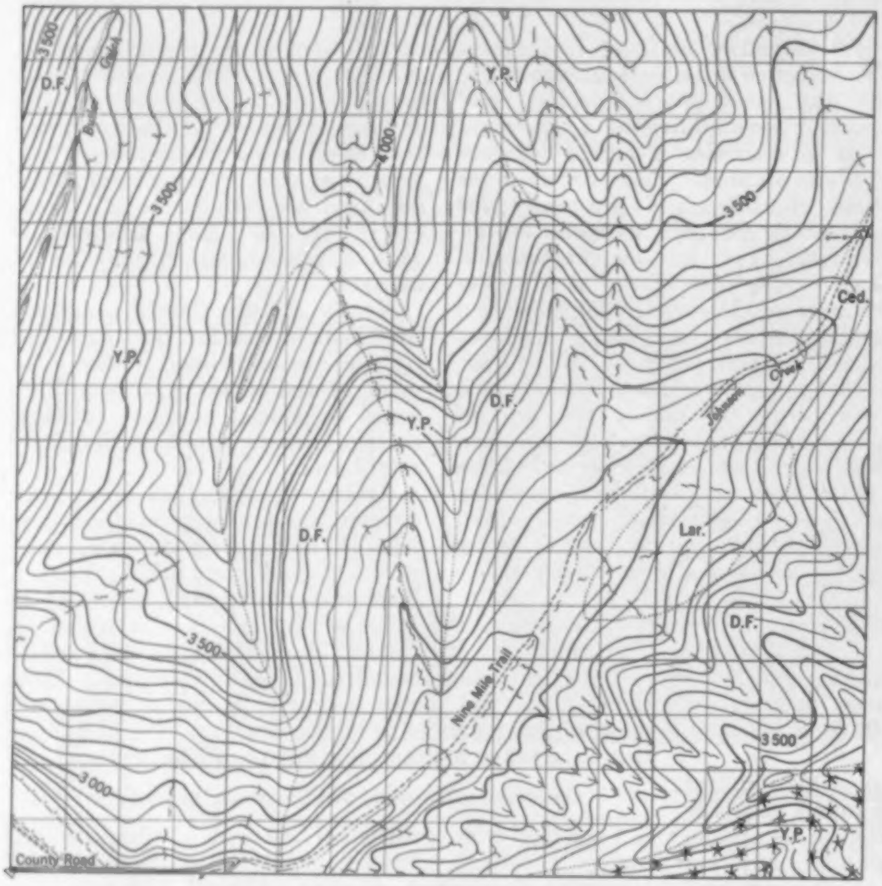


FIG. 2. SPECIMEN OF A MAP FROM A FIELD REPORT Covering One Square Mile a Few Miles Southeast of Superior, Mont.; For Predominant Timber Types Within the Dotted Boundaries, the Following Abbreviations Are Used: Y.P., Yellow Pine; D.F., Douglar Fir; Lar., Western Larch; and Ced., Cedar

diameters and heights with sufficient accuracy with his eye, and carries the stick only for occasional checks.

When a new compassman reported, he was put through an apprenticeship with an experienced man. He was required to carry a chain and check his pacing until he could consistently keep within the allowed closure of two chains per mile over any kind of ground. It required considerable practice to estimate the number of counts to "drop" when ascending or descending slopes of different degrees, or when the going was obstructed by brush, fallen timber, or swamps. The crew was obliged to re-run any line in which the closure exceeded the allowable two chains per mile. As soon as a man showed consistent accuracy, the chain was left behind, as it materially impeded progress.

Each compassman's notebook was provided with scales showing the spacing of contours for each 5 deg of slope from 0 to 45 deg. The pages of the book were provided with regular section plats to a scale of 5 in. to a mile, with "forty" lines dotted and light coordinate lines drawn at one-chain intervals. Contours were sketched to a vertical interval of 50 ft on steep slopes and 10 ft on the more gentle bottom lands. Any irregularity in the shape or size of the sections—shown by the General Land Office notes and plats—was recorded in the book before the field work was started. A typical field map is shown in Fig. 2.

In the field, the first step was to locate a section corner from which to start and to determine the direction of the section line normal to the course chosen for the examination. If the lines were reasonably clear and the corner well marked, it was customary to proceed immediately with the examination. If the lines were indistinct or lacking, and the corners difficult to locate, it was found advantageous to retrace the entire section boundary and locate as many of the monuments as possible before beginning the examination, so that no time and energy would be lost in intermittent searching for the checks at various points in the survey.

Having established the starting point, the compassman paced along the section line a distance of 5 chains and marked the point with a tripod of poles, a pile of stones, or a tree blaze that would be readily distinguishable. Then, turning at right angles, as shown by the compass, and sighting along the line in the cover of his compass box, he picked a foresight—a prominent tree or rock outcrop—as far ahead as convenient, and paced ahead, pausing at the end of every chain and picking new foresights when necessary.

Wherever a break occurred in the slope, the compassman took a reading with the "Abney," estimated a foresight height-of-instrument on a distant tree, rock, or other convenient object, and sketched the contour lines accordingly. It was also found desirable to take level shots ahead to definite landmarks when crossing ravines, thus providing a check on the elevations. Pauses were made at convenient intervals to take notes on the estimated maximum and minimum flow of streams, particularly those that were navigable or "driveable," that is, having sufficient flow in the early spring to permit the floating of logs to the mill; on roads and trails; on convenient sites for dams, mills, logging camps, and chutes; on rock outcroppings that might influence development, logging, or fire fighting; on the character of the soil; and on any indications of the presence of minerals.

Following close on the heels of the compassman came the cruiser, who counted all trees of 8 in. or more in diameter and tabulated them according to species, diameter, and height, measured in terms of 16-ft logs, over a strip one chain wide. At the end of every five chains, he counted the number of saplings under 8 in., noting the predominating species in an area of $1^1/_4$ chains in diameter. A notation was made and a new tally started wherever a decided change occurred in the density or character of the stand. Notations were also made on density and character of undergrowth and on grazing possibilities.

This procedure was repeated on two lines through each

row of "forties," making a total of eight parallel strips through each section a mile square (Fig. 2). Thus no point of the section was more than five chains, or 330 ft, from a traverse line, and very little of importance failed to be observed. At the end of every mile, a check was made on a section line and the direction was checked by pacing over to the nearest section or quarter corner. This check was also made at the half-mile point on the two outside traverses, and on the interior traverses whenever there was any reason to question the alignment.

The survey procedure described assumes that the section is rectangular and one mile square, and that it contains no obstacles to prevent the running of eight straight, parallel traverses through it. But such an ideal condition almost never occurred. When the actual size and shape had been determined from the General Land Office plats, the checks on distance and alignment had to be adjusted accordingly. Where obstacles were encountered, it was found convenient to make rectangular offsets of one or more chains, offsetting back to the original line again as soon as the obstacle was passed.

Field Conditions Dictate Methods

Where no survey lines were available, the procedure was to run compass traverses of the prominent drainage lines, and after these had been plotted to scale, to run the cruising lines approximately at right angles to them. A little care in the selection and running of the base traverses and cruising lines made possible some remarkably accurate work, even in unsurveyed areas.

While the easiest going was secured by following the general direction of the drainage lines, greater accuracy was obtained in both topography and timber estimates by working across the drainage courses, particularly when the survey lines ran in an east and west direction. The greater number of change points for topographic control permitted by the crosswise courses offset the difficulty of pacing across the drainage lines. The same increased accuracy was evident in the timber estimates, since the timber types as a rule follow the

Photo by K. D. Swan, Courtesy U.S. Forest Service

Logging on State Land Near Libby, Mont.
Mostly Yellow Pine, with Some Larch and Douglas Fir

drainage divisions, and the crosswise courses permitted a more precise definition of the boundaries of these timber types. The heaviest timber is ordinarily found on a north or east slope, the top of the ridge often marking a distinct division between timber and grassland. This is well illustrated in the southeast corner of the section shown in Fig. 2.

The compassman's notes required no office reduction except for absolute elevations, which were often computed at the beginning of the survey. Elevations were obtained from such U.S. Geological Survey bench marks or maps as were available, and from railroad records; or, if none of these was available, they were arbitrarily assumed. On some subsequent work a pocket aneroid was used to obtain elevations, and the accuracy obtained was entirely consistent with that of the other measurements. Readings were taken at all section-line intersections and at prominent points throughout the section, noting the time of each reading. The effect of atmospheric changes was eliminated by having a barometer read in camp either at hourly intervals, or at night and in the morning, pro-rating the changes throughout the day.

Photo by K. D. Swan, Courtesy U.S. Forest Service

A Fine Stand of Western Yellow Pine
Young Trees Waiting to Make New Forest When Old Trees Are Cut

Consolidation of Data

In camp, a map to the scale of $2^1/_2$ in. to the mile was kept up to date so that any discrepancies in the alignment of contours, roads, and streams could be detected and corrected before the party left the vicinity. Later, in the office, after the field season had closed, the section maps were transposed to scales of 4 and 8 in. to the mile for the general reports. Reports on timber distribution and township plats were made to a scale of 2 in. to the mile.

As an example of part of the information obtained, Fig. 2 shows a map accompanying a cruiser's report on a timber survey one mile square. The original field map, on a scale of 8 in. to the mile, was colored to show that practically all the area plotted contained an average timber stand of between 1,000 and 5,000 fbm (feet board measure) per acre. Only the small area of predominant yellow pine in the southeast "forty" was excepted, this indicating scattered trees on grassland.

TYPE OF COUNTRY MAPPED IN FIG. 2
View Looking Northeast Up Johnson Creek

In addition, a written report, not reproduced, described this area in detail. Such data as location, access facilities, land leases, topographical and geological features, soil characteristics, agricultural use, detailed timber estimates, and economic possibilities, were fully covered. Also, the cruiser reported his recommendations as to control or disposal, considering the needs of watershed protection and access for timber cutting and recreation.

CLOSE-UP OF TIMBERED LAND NEAR SUPERIOR, MONT.
Taken from the Center of Fig. 2, Looking North Up a Wooded Slope

Photo by K. D. Swan, Courtesy U.S. Forest Service

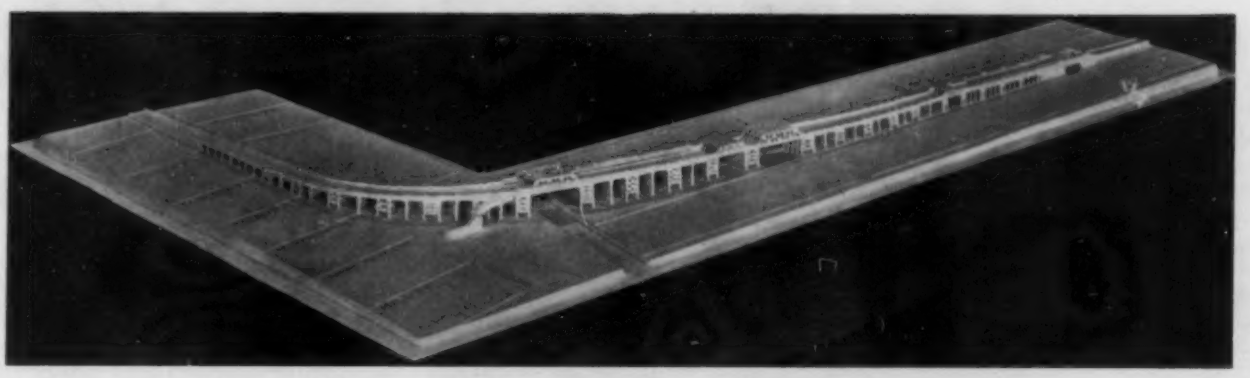
WESTERN YELLOW PINE, UPPER BITTERROOT VALLEY, MONT.

Photographs were also taken by the cruiser to illustrate some of the features reported on. A few of these are also reproduced here.

The cruiser's tallies on standing timber were reduced in the office by multiplying the tallied numbers of trees of each diameter, height, and species, by factors compiled by the U.S. Forest Service from extensive measurements of lumber actually sawn from logs of different sizes and species, thus obtaining the actual stand in feet board measure of each species on the strips covered. Since the cruiser counted the larger trees on one-tenth of the total area, a change in the decimal point gave the total stand on the "forty." These, after multiplying by an estimated "cull" factor, were indicated on the office maps by color conventions and by the notes already mentioned. The saplings were indicated in the reports in number per acre, a total area of one acre having been counted on each "forty." Where the total acreages were irregular, it was necessary to introduce a further factor in order to compensate for the variation in area.

The procedure here outlined was developed as being particularly well adapted to the existing conditions in Montana's State Forests. But the same mapping methods are effective wherever a rapid, thorough, and comprehensive survey is required, provided the numerical precision of measurements is of little importance. In the work described, the allowed linear error was $3^3/_4$ per cent, although a much greater precision was usually obtained. With a little care, the vertical error at any point was kept well within the usual limit of one-half the contour interval.

The field work, including reduction of the notes, writing the reports, and keeping the field maps up to date, was maintained at an average rate of about 200 acres per day for each crew during the summer months, or about half this rate when it was necessary to work with snow on the ground, or under other unfavorable weather conditions. I have no exact data available on the cost of the work, but I estimate that the completed reports cost the state in the neighborhood of 6 cents per acre. Since the areas covered were in very rugged and heavily timbered country, the average cost of such surveys should seldom exceed this amount.



MODEL OF GOWANUS CANAL CROSSING
Typical of the Detailed Study Required for the Solution of Major Subway Problems

Advances in Subway Design and Equipment

Review of Various Developments for New York System Shows Continuous Improvement

By A. I. RAISMAN

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AN amazing multiplicity of problems, both large and small, confront the builders of a subway system in a crowded metropolis. The task of construction is never completed. New York's first subway was commenced in 1900. Recently the Eighth Avenue unit of the independent, city-owned and operated system was opened to traffic. In its design and construction are incorporated all the combined experience of 32 years, during which period a billion dollars have been spent to bring the underground transportation system to its present state of perfection. This article has been prepared from a paper presented by the author before the Metropolitan Section of the Society.

MOST of the work of the subway engineer is hidden. The thoughtless traveler knows only whether he can pay his fare, board the proper train, and reach his destination both quickly and cheaply. Seldom does he consider the tremendous labor and care of building, the minute yet precise clearances, or the hidden safety devices provided for his security. Perhaps the most obvious parts of the subway system are the stations. They raise many awkward problems from an engineering point of view, as developed in my previous article in the October 1932 issue. This paper will deal with the experience of the Board of Transportation in perfecting other features of the design of New York's subways, particularly those having to do with cross section, alignment, and equipment.

The design of the typical subway bent between stations, as used on the first subway, under the late William Barclay Parsons, Hon. M. Am. Soc. C.E., as Chief Engineer, has been largely retained in subsequent work during the past 30 years. There has been a marked development in the layout of facilities for handling traffic, and special problems have been solved, but the basic structural design has changed little. In Fig. 1 are shown typical bents designed for the first subway and for the new independent city-owned and operated system.

Bents are spaced approximately 5 ft on centers. In the typical case they are connected only by tie rods and the concrete arches between them. This permits greater elasticity in the field. On a tangent the movement of a bent as much as 1 ft longitudinally to accommodate the restoration of some subsurface structure would not be seriously objectionable. Erection of steel may begin at almost any point, and a bent may be omitted for the time being if necessary to avoid interference with a temporary structure.

Knee braces between the roof beams and the side columns have been eliminated in our recent work. They were originally provided to hold the steel in line during construction, but contractors found it preferable not to connect them until after the concrete had been placed. As they interfered with the collapsible steel forms largely used by contractors, they were eliminated.

At stations, in order to reduce the number of columns on the platforms, the column spacing is made 15 ft, and longitudinal girders are provided to transfer the roof-beam loads to the columns. This feature involves no change from the original subway design of 1900. However, the original round, cast-iron columns used on the platforms have been superseded in the newer work by a rolled or built-up H-type in steel.

In the original Contract No. 1, the structure was completely encased in three or more plies of waterproofing protected by a concrete envelope. In our later work above water level only the roof was waterproofed. It was thought that the omission of waterproofing on the sides would result in a cooler subway. A slight amount of water entering on the sides was not considered a serious matter, as pumping is not expensive. Automatically operated pumps must be provided in sumps at the low points in any case, and a little work from time to time keeps the pumps in better condition.

At stations, the sides of the structure also are protected, since even a small amount of water running over the subway platforms is unsightly and is objectionable to the public. Where the structure is below the water level, the roof and floor are waterproofed with a layer of brick laid in asphalt mastic, and a 4-ply waterproofing layer protects the sides against the entrance of water.

In our later designs for structures in earth, below water level, the floor has been designed so as to provide for a uniform distribution of the loading on the subway, over the entire area, to avoid unequal settlement and consequent excessive leaks. This is important where the bottom is soft. Incidentally it provides for upward water pressure.

In the original subway design the headroom was made 12 ft 10 in. from base of rail. As the cars were 12 ft high and the rails 6 in. high, this left, theoretically, an overhead clearance of only 4 in. Settlement infringed on this 4-in. clearance, and furthermore, with

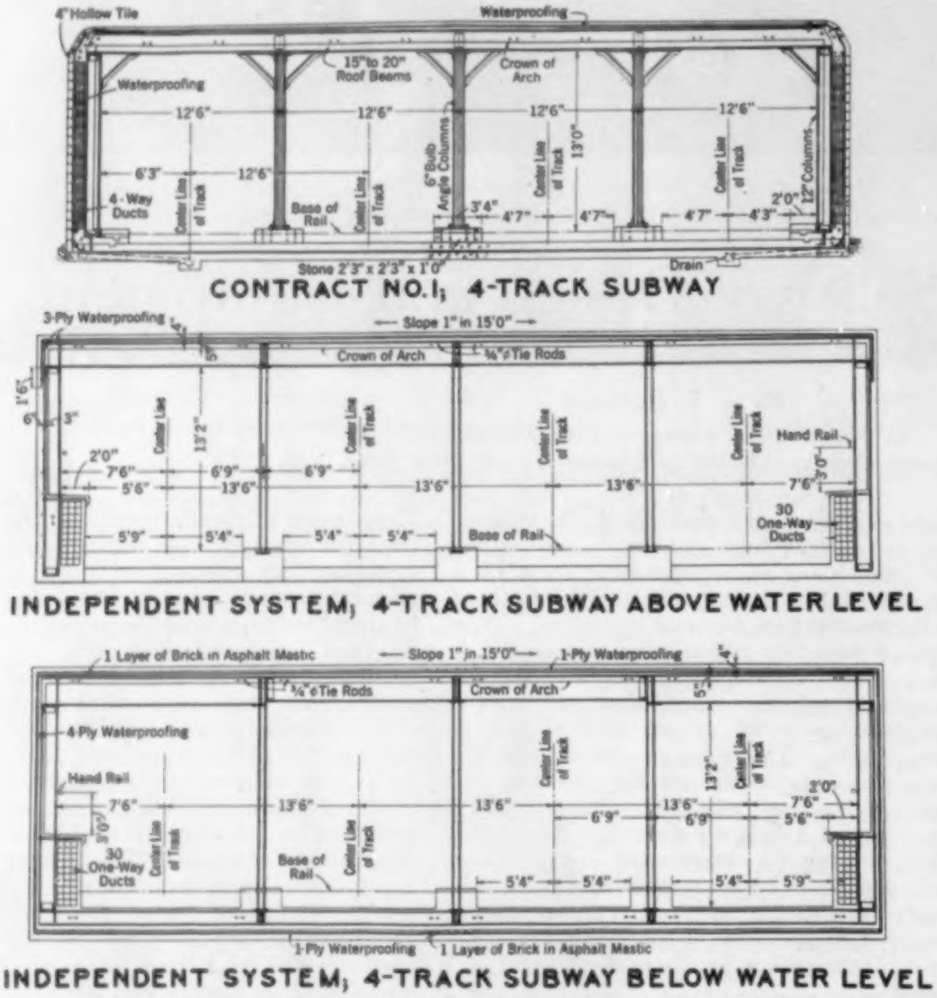


Fig. 1. Comparison of Subway Bents, Original and Present Construction
Showing Clearances and Method of Waterproofing

new springs, the top of a car was apt to be higher, so that there was very little leeway. Every inch was carefully considered so as to reduce to an absolute minimum the required climb for passengers in passing from platform to street.

In later work the distance from base of rail to under side of roof has usually been made 13 ft 2 in., or 13 ft 4 in. in soft ground where settlement might be expected, and 15 ft 2 in. where, by reason of other limitations, the depth of the subway cut and the cost were not thereby increased. This additional space would be valuable should a train be derailed at such a point.

In the newer work, the top of the structure is generally kept low enough so that there will be about 6 ft of clear space between the roof and the street surface, instead of 3 or 4 ft, as in the original subway. This 6 ft is usually sufficient to permit the restoration of all subsurface structures except sewers, which are generally placed on the sides of the structure. To care for the special congestion at street intersections, depressed bays are usually provided in the roof of the subway at such points to increase the clear space. At points of extraordinary congestion of subsurface structures, the depth from subway roof to street surface has been increased to meet the requirements of each particular case.

The original track plans showed each rail anchored in a longitudinal trough formed by an 8-in. channel on one side and an 11-in. channel on the other, both being fastened to 4-in. crosswise tees 6 ft apart, laid at right angles to the rails and embedded in concrete (Fig. 2). The 80-lb rail was to rest on 4-in. blocks placed at the level of the bottom flanges of the channels, and the rails were to be held laterally by wooden wedges bolted to the channels. This type of track, however, was never installed in the subway. Observation of some experimental track led to the adoption instead of a ballasted section 10 in. in depth, with 5 in. of ballast under the 5-in. ties, as shown in Fig. 2. At very tight points it was necessary to reduce even this 5 in. of ballast.

Under the next two contracts, the ties were increased to 6 in. in thickness and the amount of ballast under the track was raised to about $7^1/_2$ in. At stations, a so-called "Type II" track was used, with each rail independently supported on short wooden ties 30 in. long, 10 in. wide, and 6 in. deep, embedded in concrete. The rail rested on shoulder tie plates, $^1/_2$ in. thick, fastened to the wooden blocks with screw spikes. A drainage trough 2 ft 5 in. wide and about 7 in. deep was provided between the rails. The blocks were of long-leaf yellow pine with a large percentage of heartwood to resist mechanical wear, and were creosoted to prevent decay.

In the new system of subways, this Type II track is used everywhere except at turnouts and crossovers. It is considered advantageous in that the alignment and grade are well maintained, satisfactory drainage is secured, and in general there is a saving in initial cost, due to the omission of a large part of the under drains that are required when ballasted track. There is also a material reduction in maintenance cost.

In the first subway, it was also the policy to use as much vault-light construction in the sidewalks above stations as conditions would permit, on the theory that there should be as much daylight at stations as was feasible. But the operating companies found it cheaper to light the platforms at all hours by electricity than to maintain the vault lights in good condition. To ensure continuous lighting, current is provided from two or more sources.

Ventilation by Piston Action of Trains Found to Be Insufficient

In the original subway it was the general opinion, fortified by the report of a committee of experts, that special ventilation was not necessary, that the entrances

provided enough openings, and that the piston action of the trains would do the rest. However, this provision was found insufficient and some additional openings had to be provided (Fig. 3).

Under later plans, walls were used to separate trains running in opposite directions so that the piston action of one would not be short-circuited by the counter action of the other. In general, the ventilation system was assumed to exhaust air between stations and to bring in fresh air at stations. In the event of a fire, so that trains could not operate, fan chambers between stations exhausted the fumes so that fresh air would enter at the stations. The gratings in the sidewalk, for the usual exhaust or intake, were made large enough to renew the air every 15 min at the velocity of one mile per hour.

While in general the ventilation of the new subways conforms to that outlined, in some instances it has been found advisable to adopt a different system to avoid the placement of gratings in narrow, congested sidewalks. The public tends to avoid gratings, and on narrow sidewalks they cause crowding on to the adjacent solid surface and thus restrict pedestrian movement. Therefore, in some cases, in order that narrow sidewalks can be used to their full capacity, ventilation is provided through air shafts and fan chambers built into the stations and extended to the rear of a piece of property acquired for that purpose, with similar shafts and fan chambers between stations. The shafts are made large enough so that, without the use of fans, they furnish

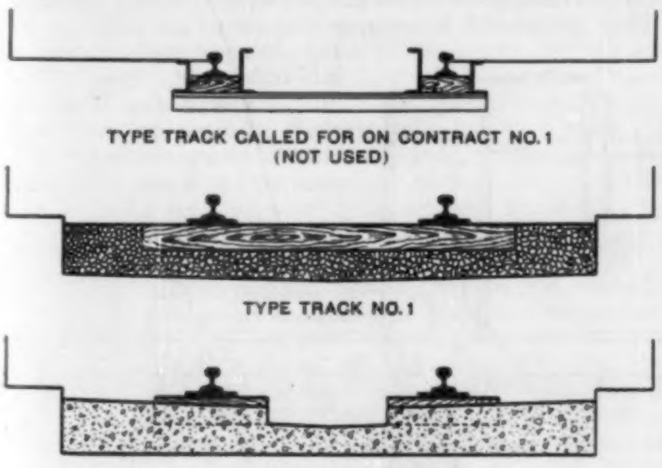


FIG. 2. DEVELOPMENT OF TRACK WORK
Latest Design Omits Cross Ties

about 30 per cent of the usual subway ventilation.

The emergency equipment in the intermediate shafts can exhaust all the air in its section in 15 min, fresh air being admitted through the shafts at the stations. The fan equipment in the stations is designed to supply fresh air if it is found during hot weather that the natural air flow is not sufficient for proper ventilation.

In the early subways many sharp curves were permitted, the minimum radius being 147.25 ft at the City Hall Station. The southbound local track at 42d Street and Park Avenue had a radius of 180 ft and the Battery Loop, one of 191 ft. In our newer work, where lack of space prevents the use of a 2,300-ft radius on curves, for which we provide little or no superelevation, an effort is made to keep the radius as long as possible—at least 500 ft. But what might be called

INTERIOR OF THE NEW 42D STREET STATION
Eighth Avenue Subway Line, Opened in September 1932

the absolute minimum is 350 ft, and that is used only where necessary to reduce the taking of expensive property.

TABLE I. EXTRA COST OF CURVED TRACK
Four-Track Subway with Central Angle of 90°

Curve Radius, in Feet	Total Annual Increased Cost	Capitalized Value of Cost at 5 Per Cent
600	$ 82,000	$1,640,000
500	100,000	2,000,000
400	135,000	2,700,000
300	192,000	3,840,000

As shown in Table I, to increase the radius of a curve with a 90° central angle from 300 to 500 ft, costs about $92,000 per annum. This sum, capitalized at 5 per cent, amounts to $1,840,000, the amount it is worth while to spend for flattening a 300-ft radius to one of 500 ft. This cost is approximate and is based on certain ideal conditions, but it can be used as a general guide to judgment.

REQUIREMENTS FOR EFFICIENT OPERATION STUDIED

The question of providing the best conditions for operation is kept constantly in mind. A satisfactory curve for operation, say one of a radius of 1,200 ft, might be very objectionable at certain points, from an engineering standpoint, as for instance in the middle of a long river tunnel where it might mean slowing up or traveling under control for a large part of the run. Speeds of 40 or 50 miles per hour and even more are developed in the long runs of these river crossings. It is therefore desirable to provide a favorable alignment so that the trains can pass through with a minimum of control.

In the interest of operation, also, more crossovers have been provided in the new system for turning back trains, and more sidings have been included for storage or for handling "bad order" trains.

In our earlier work, grades of 4.5 per cent, and at certain points, of over 5 per cent, were used. Car

motors in good condition can readily negotiate these grades but there is always the danger that one or more motors in a train may break down and then the train may stall and block the line. In the newer work, an attempt is made to hold the grades down to 3 per cent or less. At certain special points—on down grades—this limit has been exceeded. At stations, a maximum average grade of 0.5 per cent has been permitted.

ELEVATED RAILROAD CONSTRUCTION AVOIDED

All the early contracts included large proportions of elevated railroad structure, averaging about 40 per cent of the route mileage. This was done for economy, since subway construction costs from three to four times as much as elevated railroad construction. But property owners made strenuous objection to an elevated railroad in front of their property, and therefore, on the new system, subway work only was proposed.

In Brooklyn, however, it developed that a subway crossing under the Gowanus Canal and the Fourth Avenue Subway at Ninth Street would have to be very deep (Fig. 4) and would cost over $10,000,000 more than an elevated crossing. The necessary approval was therefore obtained for a plan whereby the subway tracks would come to the surface in private property and rise along an embankment and elevated structure to a crossing over the canal high enough to give clear headroom for the vessels operating on Gowanus Canal. The War Department permitted a fixed bridge at this crossing with a clearance of 90 ft, as compared with 135 ft for the East River bridges. The station at this point will be the highest in the city above the street surface.

The Houston Street Subway in Manhattan presented a most difficult problem. The street was only about 50 ft wide, and borings indicated the presence of very fine sand. To make proper connections, the subway had to be a four-track line. The structure had to cross under the Brooklyn Manhattan Transit Subway (B.M.T.) at two points and under the Interborough Rapid Transit (I.R.T.) East Side Subway. The subgrade on about two-thirds of its length varied from 3 to 10 ft below tidewater level and the remaining third was much deeper, being in part as much as 30 ft below. Ground water stood at about 9 ft above tidewater level in some places. It was out of the question to have a four-track line on one level in the 50-ft street; and to make the line double-decked would have involved an extra depth of water of about 16 ft and the vastly greater hazard that one or more of the antiquated apartments bordering the right of way would slip into the cut.

After much study, it was found that it would be an ultimate economy to put all four tracks on one level, extending under private property. This property was estimated to cost many millions. However, after making due allowance for the fact that such construction would be much cheaper than in the street; that underpinning of buildings would be largely avoided; that the hazard of a catastrophe would be eliminated; and that the land would greatly increase in value by reason of the subway, so that its salvage value would be comparatively high, it was estimated that it would be advantageous to take the property. In spite of the large amount of it involved, the property was ordered condemned. The street will doubtless be widened from 50 to 80 ft and a number of obsolete buildings will be wiped out—probably to be replaced with modern structures as soon as such construction is warranted. Thus a definite civic improvement will result.

IMPROVED DESIGN OF CARS

In intensive subway operation, the ability to load and unload rapidly is of the greatest importance. The attempt is now made to keep the station stop down to about 20 sec. At the congested express stations on the I.R.T. system the cars are so crowded that considerable time is required for unloading and loading. On that account the company improved its original cars, which had end doors only, by adding a center door.

The new city-owned cars are about 60 ft long and have four sets of doors to permit of the greatest rapidity in loading and unloading. The ideal car probably would be one whose sides consisted entirely of doors. This, however, would practically do away with all seats. The new car is 10 ft wide, with a seating capacity of 60 and a standing capacity of 220 passengers compared with 44 and 156, respectively, for the I.R.T. car; and 78 and 216, respectively, for that of the B.M.T. The B.M.T. also operates an articulated car about 137 ft long, made up of three sections carried on four trucks. Each such car has a seating capacity of 160 and a standing capacity of 431. This type of car is illustrated in Fig. 5. Considering that the new cars will permit faster loading and unloading and that the longer stations will lead to the use of longer trains, it is estimated that the capacity of the new lines for the same trackage will be 50 per cent more than that of the older I.R.T. lines.

To avoid the noise of rotary converters, the new system uses mercury-arc rectifiers of 3,000-kw capacity for converting the alternating current to direct current. They are placed in underground chambers adjacent to the subway and about a half mile apart. A mercury-arc rectifier station is materially cheaper in first cost than a rotary converter station, and it is expected that

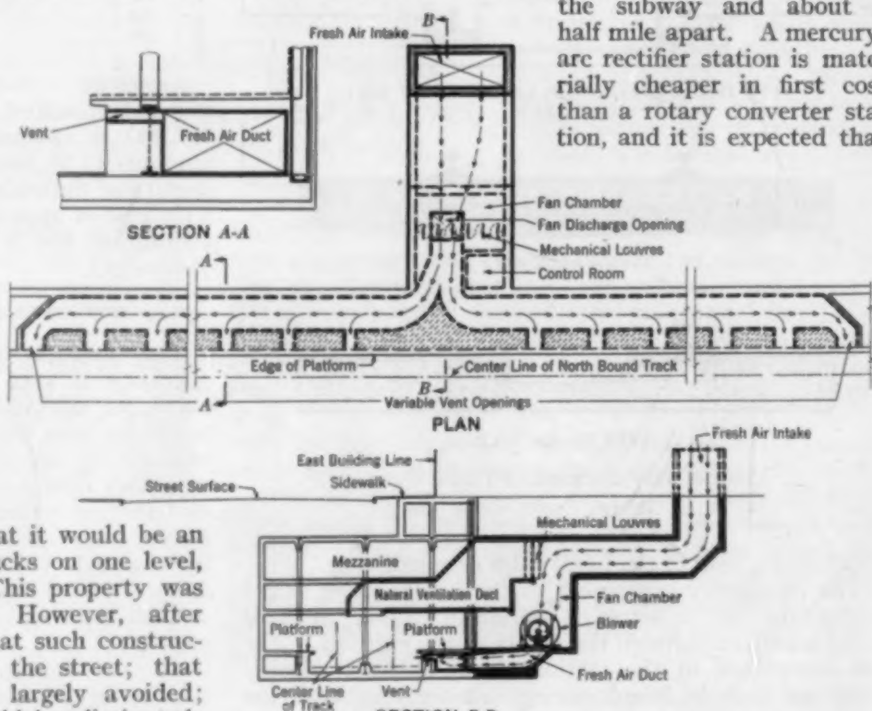
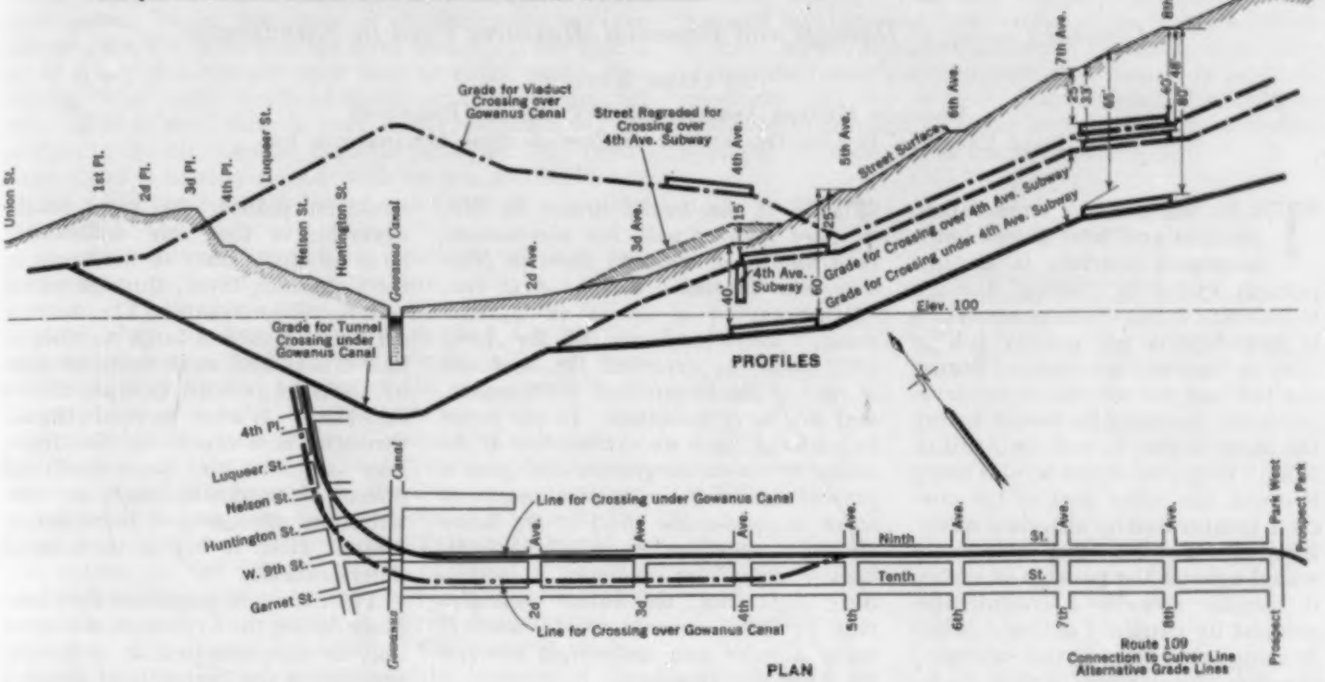


FIG. 3. SEMI-MECHANICAL VENTILATION SYSTEM ON THE HOUSTON STREET LINE
Piston Action of Train Provides Normal Ventilation

Fig. 4. Study for Gowanus Canal Crossing, Brooklyn
Adopted Structure Passes Over the Canal with 90-Ft Clearance



the operation cost will be much less also. This type of converter has not been employed extensively in such large units before, but smaller units have been used successfully both here and abroad.

SEWERS PRESENT PROBLEMS

In general, subways interfere with the existing sewers, which are normally in the center of the street at a depth of 13 ft. The expense of depressing subways to avoid the sewers would be too great to be practicable. Even then the sewers would be difficult to maintain and most of them would have to be reconstructed. Accordingly, almost every subway construction job necessitates a complete change of the sewer layout. Because of the barrier formed by the structure, sewers are generally required on both sides of the street, and frequently the direction of flow must be reversed. In a few cases sewer siphons have been necessary. In the design of sewers, the ten-year storm is now the criterion, whereas in previous work only the two-year storm was considered.

In our designing work, we get out many plans. We call for all sorts of shapes of structure and require the greatest accuracy in following our specifications. Sometimes we find it necessary on our plans to call for 60-ft cuts or for depths of 30 ft below tidewater. When we submit these plans to contractors, many of them no doubt think the designs were prepared without any thought of the difficulties that would be met in their execution. The work is becoming more and more difficult as New York City grows, but the engineers and contractors grow with it. We are glad to bear witness to the ability of the subway contractors who build what we design. We also appreciate their cooperation with our engineers in the field and in the designing office, which makes it possible to overcome all difficulties.

The Independent System is being constructed by the Board of Transportation of the City of New York, of which the Hon. John H. Delaney is Chairman, and the Hon. Daniel L. Ryan and the Hon. Frank X. Sullivan are Commissioners. Mr. Robert Ridgway, Past-President of the Society, was Chief Engineer and is now Consulting Engineer; and the late John R. Slattery, M. Am. Soc. C.E., was Deputy Chief Engineer. The author is the Chief Designing Engineer.

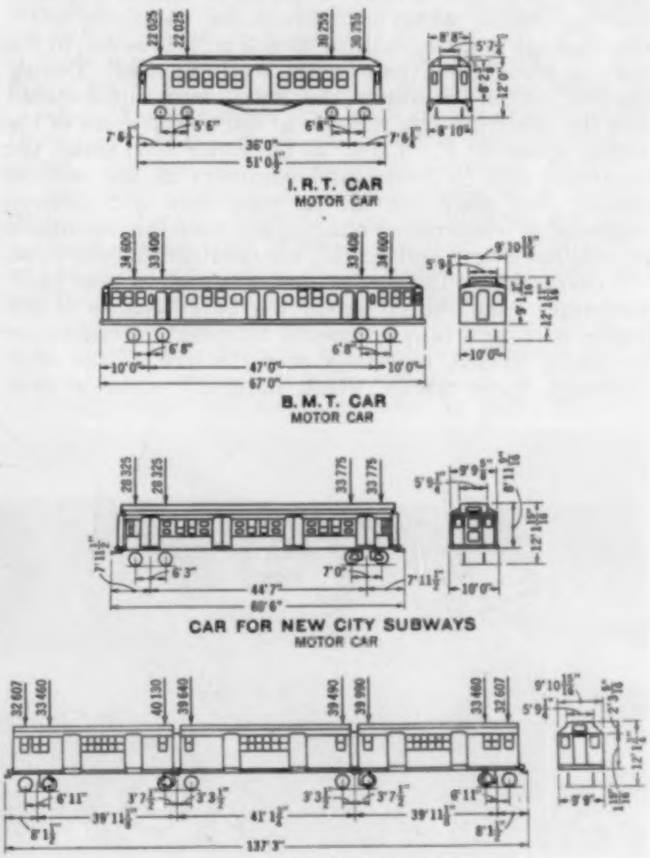


Fig. 5. Development of the Subway Car
New York Subway Systems

Preventing the Disintegration of Dams

General Causes of Damage and Remedial Measures Used in Scandinavia

By Oren Reed

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THIS is the second article by Mr. Reed dealing with his observations on a number of masonry dams in Norway and Sweden. In the first one, "Disintegration of Dams in Scandinavia," which appeared in the April 1932 issue, he described the condition of four of the largest and most important structures examined. In this paper he continues with an explanation of the causes of the disintegration and gives a general résumé of the remedial measures taken to combat the effect of the severe climatic conditions to which Scandinavian dams are subjected. Despite these difficulties, the author considers that portland cement can be used to make durable and water-tight concrete for hydraulic structures.

The effect of temperature changes and frost action on a saturated concrete is an important factor in causing damage to concrete dams. Storage reservoirs in Scandinavia are usually full in May or June and are emptied during the fall and winter, the water level generally reaching its lowest before the snow begins to melt in April or May. While the water level is being lowered, the outer part of the concrete is saturated by absorbed water. Even if the concrete is entirely sealed against the passage of water, it usually absorbs a considerable amount by capillary action. When freezing takes place in this saturated concrete, local stress action forms new cracks or enlarges existing ones.

When the temperature of the air falls, a temperature difference results between the interior of the dam and the surface, causing stresses and the formation of hair cracks. A dam is usually divided into sections by contraction joints, which counteract the damaging effect of shrinkage in a longitudinal direction. However, in the vertical plane, conditions are more complicated. During the first part of the winter, the downstream side is cooled and the upstream side remains at the temperature of the water, about 39 F. Later, as the water level sinks, the upstream side is cooled and contracts in the vertical plane. But since the central part does not undergo appreciable temperature change, and therefore maintains its original length and height, temperature stresses arise.

Contraction of the surface probably cannot take place uniformly from the crown to the base because of the center core, and thus horizontal temperature cracks are no doubt formed, especially near the base of the dam. Although these cracks, which naturally occur at construction planes, are very small, nevertheless they are sufficiently large to cause lines of weakness in the tightening layer, through which water can percolate. The mortar surface will show a large number of hair cracks and weak spots because of shrinkage and temperature stresses. Water percolates in through these cracks to the inner lean concrete and soon finds all points of weakness, such as construction planes and contraction joints. Here it begins its work of deterioration.

The chemical processes that take place during the hydration of cement may be characterized as a decomposition of the higher lime silicates into lower silicates and calcium hydroxide. The hydroxide crystals, which are of great benefit in providing strength and water-tightness, are however soluble in water, and it is this solubility that seems to be the main cause of deterioration. Water seeks its way through pores or cracks in the concrete, dissolves the hydroxide, and carries it out to the surface, where it often combines with the carbon dioxide of the air and becomes visible as a white efflorescence of calcium carbonate. Chemical analyses have proved that hydrated portland cement contains from 13 to 17 per cent of calcium hydroxide. After a time, depending on the porosity of the concrete, the total amount of the hydroxide is lost.

The dissolving of the free calcium hydroxide and the decomposition of the silicates and other lime-bearing compounds of the cement, go on at the same time. The rate of the former process is far more rapid than that of the latter, and a concrete structure subjected to percolating water is soon deprived of its total amount of free calcium hydroxide. The decomposition of the lime-bearing compounds, on the other hand, may continue until a complete breakdown of the cement takes place. From experiments and practical experience, the conclusion has been reached in recent years, that with common portland cement, and also with other cements, a concrete can be obtained that is tight against one-sided water pressure but not one that is insoluble, or even difficult to dissolve. Solubility by water is definitely a characteristic of cement.

There are many substances in water in addition to acids

Vamma Dam, Glomma River, Norway, 1921
A Concrete Gravity Structure Faced with Granite Masonry

that are believed to play a very important part in the destruction of concrete in Norway and Sweden. These substances are humus, and iron and manganese carbonates. Small amounts of humic materials are always found in Scandinavian river water. If the humic acids come into contact with lime or enter water containing lime, easily dissolved humic acid lime is divided out. Humic acid lime is very easily oxidized by the oxygen of the air, forming carbonic acid gas. However, since there is usually no air with oxygen available, the humic acids remain as a brown substance in the other materials.

In many rivers, appreciable amounts of iron and manganese carbonates are present, dissolved from marshes. These combinations are usually found in the original state as humic acid salts, but become bicarbonates later. Such ferro-carbonates will be very easily oxidized by the oxygen of the air, especially in the presence of a base, to give carbonic acid. A very strong attack can take place on a concrete structure in this manner, and the presence of such combinations in the water explains the presence of the iron and manganese deposits often found in damaged concrete and in the slime that collects in the inspection galleries of dams.

A reason for the damage to the concrete of Scandinavian dams is indicated by the composition of the water from the rivers. Pure water is extremely corrosive to concrete. The degree of acidity of the water is an important factor. Water becomes acidic because of dissolved humic, carbonic, or other acids. Analyses of river water at six dam sites in Norway and at five in Sweden are given in Table I. The hydrogen-ion concentration, or pH number, is low in each case studied and indicates an acidic and clean water.

No appreciable difference could be noted in the composition of the water in a drainage system near the river mouth and at stations closer to the source. The season of the year also made no characteristic change in its composition. The Glomma River has a high pH number and the greatest amount of fixed carbonic acid of any stream studied in Norway. This is probably due to the fact that the stream flows through more cultivated land than the other rivers investigated. Similar conditions are prevalent on the Dal River in Sweden. For that reason the water of these streams should not be very corrosive to concrete. However, this characteristic is partly counteracted by the greater content of organic materials.

Preventive and Remedial Measures Classified

The various means that might be used to prevent the destruction of concrete in dams can be classified in three main groups, as follows:

1. A cement might be manufactured that would be entirely resistant to the water found at the dam site; probably an admixture, which makes ordinary cement resistant, would have to be added.
2. An attempt could be made to prevent the entrance of water into the concrete, either by making the concrete water-tight by such means as better proportioning of material or by using admixtures.
3. An entirely water-tight, elastic, and durable coating might be applied to the upstream face.

Since, during hydration, ordinary portland cement gives off free lime and lime combinations that are soluble in acidic water, attention has been fixed on the possibility of manufacturing a more resistant cement. It would be necessary that this cement, when hardened, should be insoluble to percolating water and should have sufficient strength in tension and compression.

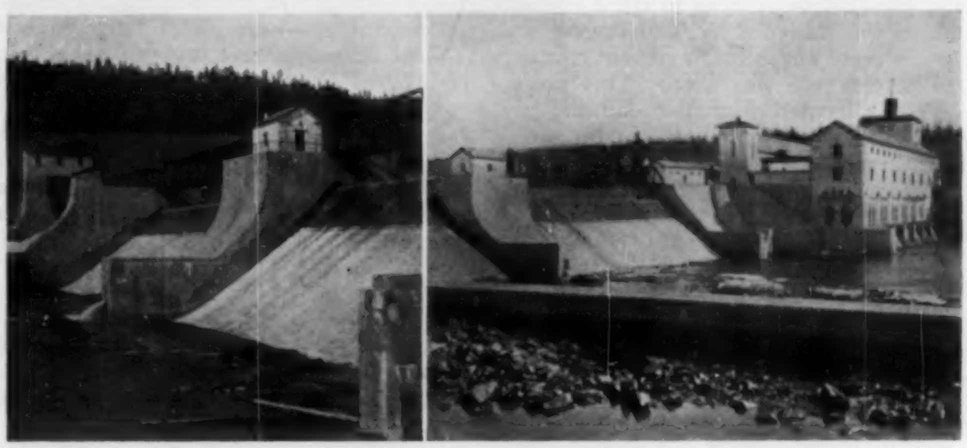
Table I. Results of Analyses of River Water at Eleven Dam Sites in Scandinavia

Location	pH Number	Dry Matter Content Mg per Liter	Bio-Chemical Oxygen Demand Mg per Liter	Carbon Dioxide Mg per Liter Free	Carbon Dioxide Mg per Liter Fixed
Norway:					
Mörkfoss	6.7	36	6.3	2.74	13.69
Nore	6.2	17	3.4	2.59	6.65
Rjukan	6.0	10	2.3	2.49	5.54
Notodden	6.0	13	2.8	2.64	6.06
Tyssefaldene	5.9	7	1.0	2.30	3.62
Lerfoss	6.8	26	3.9	2.05	12.79
Sweden:					
Porjus	6.6	18	5.4	3.8	3.2
Knutsbro	6.8	28	7.9	7.8	12.4
Älvkarleby	6.5	99	6.2	5.5	4.5
Norrfors	6.5	28	6.7	6.0	4.4
Trollhätten	6.6	27	4.3	3.6	4.1

Engineering opinion is now diverging from the old belief that all cements are uniform. Although two cement specimens may show equal strength, one may be greatly superior to the other in durability. Durable concrete for outdoor exposure can be made only from a cement that will develop hydration products which will last and will continue to resist the corrosive agents present at the site in question.

Tests have proved that a tight concrete may be produced by using a finely ground cement. However, in practice, concrete made from such special cement might form hair cracks, which would allow the entrance of water. In this case, the concrete would be destroyed in the same manner as concrete made from normal portland cement. Therefore, for the present, the usual portland cement must be used for hydraulic construction and an endeavor must be made to produce concrete that will be more resistant to aggressive water.

To make a tight concrete, which water cannot enter even under high pressure, is therefore a rational means of preventing destruction of the material, since the water can only attack the outer surface. In a gravity dam



Norwegian Concrete Dam Protected with Granite Masonry
60-Ft Raanaasfos Dam, on the Glomma River; Length 590 Ft

a very tight concrete is required for the waterproofing layer on the upstream face. It would not be possible, for economic reasons, to construct the whole structure of cement so proportioned as to be equally tight.

Determination of the proper proportioning of the aggregate with which all the voids will be filled must be made for each job, taking into account the materials available. Experience with concrete in recent years has proved that the requirement of an exact gradation of grains for the sand can often be advantageously reduced if a concrete mixture richer in cement is used, especially for hydraulic construction.

GRANITE FACING ON SPILLWAY PIERS
Untra Dam, Dal River, Sweden

Since the purity and composition of the sand are of special importance in obtaining a good mortar, this aggregate must be carefully tested for organic and inorganic impurities. Coarse aggregate should be given attention, especially as to gradation. Without determining sieve curves and the combined mix curve, no useful indication can be obtained of the suitability and economic practicability of the aggregates. The mix curve should follow slightly above the Fuller curve, in order that the concrete may be plastic. After the aggregate curve is determined, tests should be made of different mixes to fix the proportions of mixing water and cement. For the tightening layer of gravity dams and for the thin reinforced sections of hydraulic construction, between 590 and 675 lb of cement per cu yd of concrete, dependent on the fineness of the sand, must be used. For the thin reinforced sections of the dam for the Perak development in the Federated Malay States, which was designed by, and the construction controlled by, Swedish engineers, a cement content of 773 lb per cu yd of concrete was used. This project, completed in 1930, is located near the equator and is never subjected to cold temperatures.

The effect of the amount of water added to the mix on the strength and tightness of the concrete should be studied. Many tests show that for a definite mix and given aggregates the tightest concrete has a plastic consistency. This requires a water-cement factor of from 0.55 to 0.60 for a $1:2:2^1/_2$ mixture, but such a concrete will be difficult to chute in the flat, sloping chutes now generally used, and bucket placing must be employed. The water-cement ratio, taking into account the moisture absorbed by the aggregates, must be held constant during the entire construction. A mixing time of 2 min should be the minimum for concrete used in hydraulic work.

Both practice and tests have shown that the proper curing conditions must obtain to produce a tight and resistant concrete. If the face is kept moist during curing, calcium carbonate compounds are formed near the surface, and these tend to fill and tighten the pores of the concrete. Immediately after the forms are removed, a perforated water pipe should be placed near the crown of the section and the surface kept moist until the structure is placed in service.

TIGHTENING RINGEDALS DAM BY GROUTING

For dams in Scandinavia, where surface repairs have not been found sufficient and where investigations have shown a weak, porous concrete in the interior of the dam, grouting has been employed to tighten the concrete. However, results have not been consistent and most of the grout has been lost.

During the summer of 1927 an attempt was made to grout the porous concrete of the tightening layer on the front face of the Ringedals Dam, in western Norway. This layer is made of $1:2^1/_2:3$ concrete and its thickness varies from 3 to 10 ft. Immediately back of it is located the drainage system. Grouting was done at a point near the maximum section by drilling holes 5 ft apart and to a depth varying from 50 to 73 ft. The grouting was not entirely satisfactory, for although the leakage was reduced, it was not eliminated. Therefore the process of corrosion and disintegration would continue and after a short time the grouting would have to be repeated. A part of the drainage system was cut off by the grout and ceased to function. If the leakage water should reach the lean concrete back of the drain pipes, its destructive action would be rapid.

ADMIXTURES AND SPECIAL COVERINGS FOR THE WATER FACE

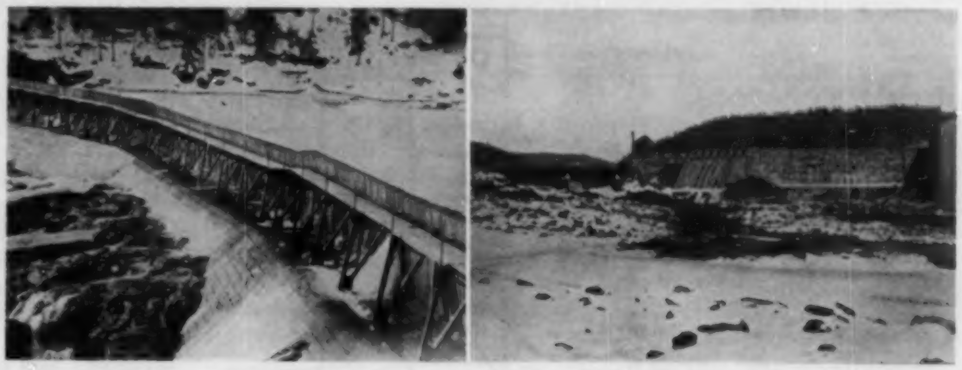
The possibility of using certain admixtures to make concrete tight and resistant to the attack of water has been studied for many years in Europe. The fact that such materials can remain on the open market proves that there is an active demand for a reliable admixture. No doubt many of those that are advertised and sold have no effect, or even have a harmful effect, on the concrete. The effect of admixtures is dependent on the composition and structure of the sand and gravel and even more on the chemical and physical characteristics of the cement, especially its fineness. In the case of a number of materials containing active silica, it has been found that the silica combines with the free lime of the hydrated mixture to form less soluble compounds, but most other materials have little or no beneficial effect.

A SWEDISH MULTIPLE-ARCH STRUCTURE
Norrfors Dam, Ume River

The upstream faces of many dams have been covered with mortar, usually a $1:1^1/_2$ or $1:2$ mix, and gunite has also been used in recent years. In general, such coatings have not given effective protection against the percolation of water. This has been due partly to the fact that the mortar has not adhered completely to the body of the dam and partly to the fact that shrinkage and temperature forces have formed hair cracks in the facing, and through these the water has

percolated. If the tightening layer of the dam is poured against steel or planed wood forms, the surface should be fully as dense as a mortar facing.

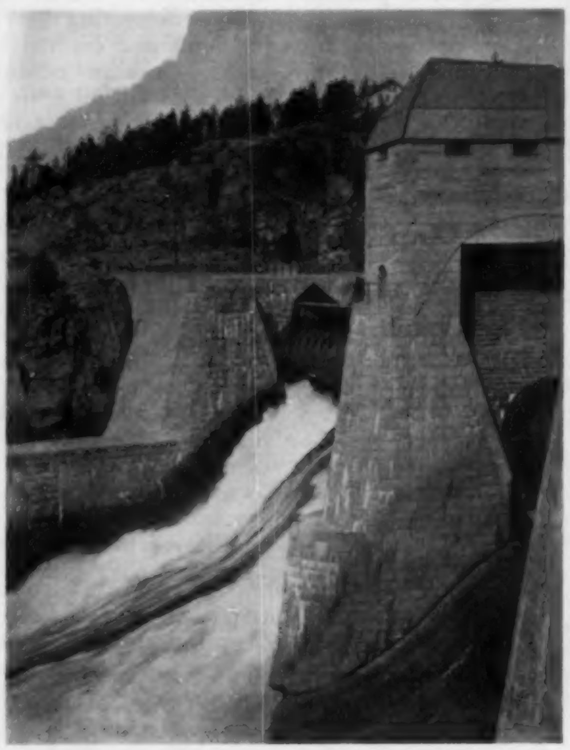
Another remedy against the attack of water on concrete is a protective coating, of which there are many kinds on the market. They may be divided into two main groups: materials that act chemically to form harder and less soluble combinations on the surface, and ordinary surface coatings. A number of fluorine combinations now in extensive use belong to the first group. These act through the combination of the fluorine with the lime of the concrete to form calcium fluoride, which is difficult to dissolve. Such coatings and other chemical combinations no doubt add to the durability of the concrete, and they are especially useful in forming a hard and dust-free indoor floor. However, they do not make the surface more elastic, and therefore do not lessen the formation of shrinkage and temperature cracks. For this reason they are of minor importance in protecting a concrete dam from the attack of water.



KYKKELSRUD DAM, GLOMMA RIVER, NORWAY

The second group includes oils, paints containing oil, paraffin solutions, paints whose base is cement, and asphalt and tar products. In the first classification, there are a number of products on the market that have been used for indoor work. For dam construction they will probably give a certain amount of protection because they tend to tighten the concrete. However, since by their use the surface concrete will not be more elastic, shrinkage and temperature cracks will be formed.

Most of the coatings used for hydraulic construction are liquid asphalt and tar products. These are poorly adapted as a protection against the attack of water because the dissolved materials do not remain in the surface pores of the concrete and the water can seep through by diffusion. Tests show that there is a wide difference between the tightness of different materials and that none of the protective coatings are entirely watertight. By the use of a good waterproofing paint or compound, the formation of cracks can be reduced to a certain extent without other protection. However, a concrete dam cannot be completely protected by a waterproofing coating from the percolation of water or its mechanical erosion.



MÖRKFOSS-SOLBERGFOSS DAM, GLOMMA RIVER, NORWAY

Waterproofing membranes or paper have been used for many years on such structures as bridges and water tanks, but seldom on dams. Such a membrane is formed by heating asphalt or coal-tar pitch to a liquid or semi-liquid consistency and applying it with a brush. When cooled, it must be stiff and at the same time elastic. To use an insulating paper or felt, the wall must be coated with a sizing to hold the paper. The paper or felt is then saturated either with an asphalt or a tar product. Often several sheets of waterproofing are used with a layer of sizing between each.

It should be possible to obtain a tight outer surface by means of such a waterproofing paper. The body of the dam would then need to take only the water pressure. This waterproofing must be elastic enough to follow all temperature variations and cover the shrinkage and temperature cracks that form in the concrete. Since these membranes and paper have little mechanical strength, they are easily scraped from the face of the dam by ice action unless protected. Gunite or a concrete deck may be used for this purpose.

In the case of the Ringedals Dam, which had suffered serious corrosion and disintegration, a reinforced concrete curtain wall was built $6^1/_2$ ft in front of the old structure to take the full water load, the original dam serving only as a support for the deck. This separate vertical water curtain was decided upon after different methods of repair had been tried, such as renewing the joint mortar, coating the upstream face with a waterproofing compound, and pressure grouting. The work was completed in 1931.

GRANITE MASONRY FACINGS

It was natural that European engineers, who were well acquainted with the resistant qualities of granite and similar native stones through years of masonry dam construction before the advent of concrete, should turn to the use of granite blocks as a facing where unfavorable conditions were encountered. Notable examples of this type of construction are the Tunhövd, Ringedals, Lienfos, Raanaasfos, and Vamma dams in Norway, and the Porjus, Älvkarleby, Untra, and Forshuvudfors dams in Sweden.

In contrast to the usual practice, in which the stones are merely set in the facing concrete, special attention was paid at the Forshuvudfors Dam in Sweden to the effec-

tive anchoring of the facing by means of hooked rods. This concrete gravity dam, 52 ft high and 410 ft long, was completed in 1922. In the body of the dam the mix was 1:4:6, but on the piers and spillway slopes a rich mix of $1:2^1/_2:3$, and $27^1/_2$ in. thick, was used. Each stone on the spillway was anchored from its upstream edge by means of hooked rods extending into the underlying rich concrete, and was also keyed from its

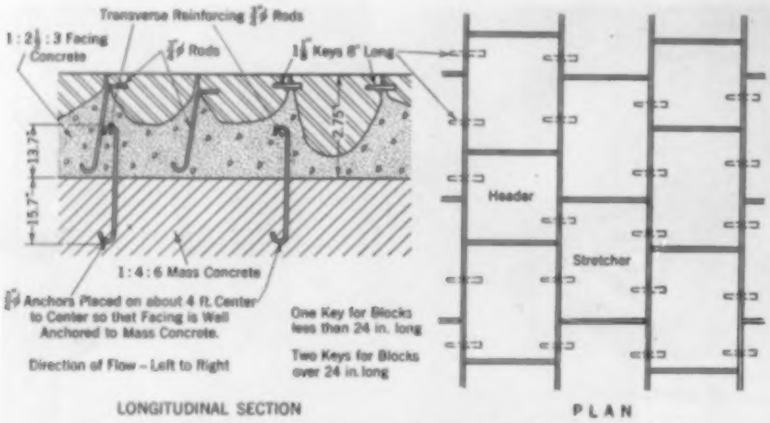


FIG. 1. METHOD OF ATTACHING FACING OF GRANITE BLOCKS
Forshuvudfors Dam, Dal River, Sweden

downstream edge into the stone next below, as shown in Fig. 1. The facing concrete in turn was bonded by reinforcing steel to the mass concrete. On the piers, the facing, which is affected by spill, was anchored into the concrete but the stones were not keyed together.

To facilitate grouting, joints were made $^3/_4$ in. wide. A 1:3 grout was used to point the joints. On the lower part of the three highest piers, which are inaccessible for maintenance after the reservoir fills, and at points on the spillway slope where the water attains a high velocity, pointing of joints with cement grout was not considered sufficient, and therefore the joints parallel to the flow of water were filled with lead. The stones were hewn for a $^1/_4$-in. joint, and soft lead strip, $^3/_{16}$ by $1^{15}/_{16}$ in., was laid between the courses, projecting $^3/_8$ in. beyond the wall line. After the concrete had hardened, the projecting lead was hammered into the joint, forming a smooth surface. Pointing and leading of joints were done at least two weeks after the concrete was poured so that a large part of the setting heat in the concrete back of the facing would have time to dissipate.

Opinion among engineers is divided as to the utility of a stone facing for dams. The thermal and elastic properties of concrete and granite are different, and where a large temperature variation is experienced, the granite facing is broken loose from the concrete body and a ready passage for leakage water is formed through the joints of the facing. There is a definite trend in Sweden away from the use of stone facings.

The Hammerforsen and Lanforsen dams, completed in 1928 and 1930, respectively, were built without stone facings but a relatively rich mix was used near the upstream face and on the spillway surfaces. The mixture at Hammerforsen was $1:2^1/_4:2^3/_4$ in all but very massive sections, where a 1:3:5 mix was used. The lean mix was, however, never used on water surfaces. At Lanforsen, the normal mix was 1:2.4:2.9. Trass was added to the mix in a proportion amounting to from 18 to 20 per cent by weight of the cement. Practically all the concrete surfaces were left plain, only the pier faces of the main flood opening at Hammerforsen being provided with protection in the form of $^3/_8$-in. steel plate. Nearly all the run of lumber, amounting to 10 or 15 million logs each year, is passed through this spillway opening. At Lanforsen there is a separate log chute, and no timber is passed over the spillways.

ADVANTAGES OF THIN ARCH AND SLAB CONSTRUCTION

With the knowledge and experience with concrete gained in recent years, a type of construction can be selected that will suit the characteristics of the materials. For a gravity dam, the weight is utilized, while the strength of the material is less important. Since the inner part of such a dam is difficult to control effectively, and defects are not easy to localize on account of the large mass, a more rational and economical type of construction should be substituted.

Materials are better utilized in a thin dam of single-arch, multiple-arch, or flat-deck construction. Since the mass is small and the materials are stressed, the type is economical. In addition to this advantage, the arch dam is easily controlled on account of its relatively thin members, and any possible damage can be easily located and repaired. In this type of construction only the tight, rich concrete is subjected to the action of the water. Temperature and shrinkage stresses are secondary, and uplift need not be considered.

Insulation of the thin arch and deck construction should be provided to prevent freezing of the concrete on the downstream side. A thin, vertical wall between the buttresses is a better solution of this problem than the dead-air chamber back of the toe, as used at Norrfors in Sweden. A necessary condition for the construction of a thin-type dam is an absolutely tight concrete and a sufficient covering for the reinforcement. Because of the much smaller quantities, it is economically possible to use a much richer mixture than can be used in a gravity dam. There may be purely local conditions, however, that will dictate the selection of a gravity dam.

After inspecting the Porjus and Untra earth-and-gravel fill dams and comparing their condition with concrete dams in similar locations, I am led to believe that a properly built fill is to be preferred to a gravity dam in locations where cold temperatures are experienced and where the fill type of dam is not prohibited by lack of suitable materials and excessive height. Where suitable materials are to be found locally, the cost of the fill dam is less, if the average height is not excessive. The limiting height varies according to the location of the site and the availability of suitable materials for concrete. In many places, the local materials, which are entirely suitable for a fill, would not serve for concrete without expensive washing and grading.

The upstream slope especially must be able to withstand erosion by rainfall, waves, and ice thrust. For fill dams, the spillway should either be an amply proportioned concrete wasteway or else it should be located at a natural site remote from the fill. Spillway regulation should be of a positive type. Foundation conditions will often be more favorable for a fill-type dam than for a gravity structure. A composite dam—fill and concrete—has elements of danger at the points of junction.

Investigations indicate clearly that, if the concrete is made and placed in such a way as to avoid the percolation of water, there is no ground for the supposition that portland cement, at least under normal circumstances, cannot be regarded as a sufficiently durable material for hydraulic structures.

Surveying Under Compressed Air

Great Accuracy Obtained in "Holing-Through" Sewer Tunnel Headings at Columbus, Ohio

By Orris Bonney

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ON May 14, 1929, a contract was awarded by the City of Columbus, Ohio, for the construction of Section 1 of the Alum Creek Intercepting Sewer, a circular sewer of 5-ft internal diameter, which is about 3.5 miles long and extends across the southern part of the city in a general easterly and westerly direction. Of the total length of sewer constructed under this contract, about 2.8 miles were built in tunnel from seven shafts located from 1,700 to 2,400 ft apart. For purposes of identification and convenience of reference, each shaft was assigned a number. The first shaft sunk was located near the middle of the work and was designated Shaft 7, with the thought that six others might later be sunk to the west of this one. Actually, only three were sunk in that direction, and the shafts were therefore numbered consecutively from 4 to 10 inclusive, there being no shaft numbered 1, 2, or 3. In Fig. 1 are shown a plan and a profile of the sewer, the stations and distances being given to the nearest foot.

WHILE many structures have been constructed in tunnel and considerable literature describing various tunnel projects has been published, information in regard to the differences in alignment and elevation at the meeting of tunnel headings is not often published. This record of experience in Columbus, Ohio, in the construction of a 5-ft sewer in tunnel under compressed air, therefore will be of interest. Except for a relatively short distance, the tunnel construction on this project was in earth.

SOFT GROUND REQUIRED COMPRESSED AIR

The contract provided for the use of compressed air in the tunnel headings when ordered by the engineer, and in the construction of shafts, if the ground conditions encountered required its use. Compressed air was maintained in all tunnel headings throughout the construction of the work and, with the exception of Shaft 4, was employed in sinking the shafts. An air pressure of 15 lb per sq in. above atmospheric pressure, was normally required, although it was varied from a maximum of 35 lb to a minimum of 6 or 7 lb per sq in. The tunnel headings were driven in both directions from each of the seven shafts. The longest heading was 1,380 ft and the shortest was 644 ft.

At the beginning of the tunnel work there was insufficient room at the bottom of the shafts for the establishment of accurate base lines and the use of a transit. It was therefore necessary, except at Shaft 4, to establish tentatively the center line of the sewer from temporary points located by transit in each of two walls of the shafts prior to the installation of the vertical shaft locks. At Shaft 4, constructed under free air, temporary points on the center line were obtained by heavy plumb bobs suspended from the surface. At Shafts 4, 5, 8, and 9, approximately 40 lin ft of tunnel were constructed in both directions using these temporary points, to permit of the construction of the horizontal tunnel locks. At Shafts 6, 7, and 10, from these temporary points a length of tunnel was constructed in each heading just sufficient for the establishment of the accurate base lines and the use of the transit, this length being approximately 10 lin ft at Shafts 6 and 7 and approximately 20 lin ft at Shaft 10.

Except for the relatively short lengths of tunnel constructed at the beginning of the work, alignment was carried into the tunnel headings from accurate base lines, which varied in length from about 13 ft as a minimum, to about 36 ft as a maximum. The length of base line used at each shaft is shown in Table I.

These base lines were established by means of plumb lines hanging from the surface or from the deck of the shaft locks, and the plumb line, which consisted of 12-gage piano wire with a 44-lb lead weight at the bottom, was suspended in a bucket of water. At Shafts 6 and 7, the plumb lines were free-hanging within the shafts but at all other shafts one plumb line was within the shaft and the other was in a 6-in. casing driven down adjacent to the shaft. At Shafts 4, 5, 8, and 9, the center line was not established until the horizontal tunnel locks were in operation and the shafts under free air conditions; whereas at Shafts 6, 7, and 10 it was necessary to do the work with the vertical shaft locks in place and the shafts and headings under compressed air. At Shafts 6 and 7, the plumb lines were suspended from reels at the top of the shaft, and through 6-in. pipes projecting through the lower deck of the shaft lock.

Table I. Lengths of Base Lines at Shafts

Shaft Number	Length of Base Line in Feet	Condition of Air in Shaft During Establishment of Base Line
4	22.05	Free
5	22.11	Free
6	13.48	Compressed
7	13.16	Compressed
8	21.70	Free
9	21.56	Free
10	36.62	Compressed

METHOD USED UNDER COMPRESSED AIR

The upper end of each pipe was fitted with a screw cap through which a number of small holes slightly larger in diameter than the piano wire were drilled on a radial line. A cap placed on the lower end of the pipe permitted the removal of the upper cap without the loss of compressed air. The piano wire was then threaded through one of the small openings in the upper cap, and a light-weight plumb bob was attached to the end of the wire. The plumb bob and wire were placed in the pipe, and the cap replaced and turned until the hole through which the wire was hanging was on line, the line being determined from above by a transit set up at the top of the shaft. As soon as the upper cap was in place, the lower cap was removed, the wire lowered by the reel, and observations made from below to make sure that the wire was hanging free within the pipe.

If the wire was not hanging free, this same procedure was repeated, using another of the small openings in the upper cap, until one was found which permitted

the wire to hang without touching the pipe. The wire was then further unreeled and lowered to the bottom of the shaft. Then the light-weight plumb bob was replaced by the 44-lb lead weight, which was suspended in a bucket of water.

At Shaft 10, where one plumb line was suspended in the shaft and the other in a 6-in. cased hole driven down near the shaft, the general procedure in establishing the base line in the tunnel was similar to that at Shafts 6 and 7. As a precaution against possible errors, the base lines were checked under free air conditions as soon as the shaft locks were removed. Longitudinal sections of Shafts 6, 7, and 10, illustrating the method of establishing the base lines with the shafts and headings under compressed air, are shown in Fig. 2.

With the plumb lines suspended on line at the bottom of the shafts, the transit was set up approximately on line in the tunnel and about 10 ft from the nearest suspended wire. It was then lined in on the two wires, the nearest wire being focused out of vision when sighting on the other, and vice versa. Having thus established a point on the center line of the sewer, a number of other points on line were then set in the roof of the tunnel. As the tunnel headings progressed, transit points were set at intervals of about 100 ft. Ordinarily, visibility was such that, with the transit set on one point, another point ahead as well as a point to the rear could be seen.

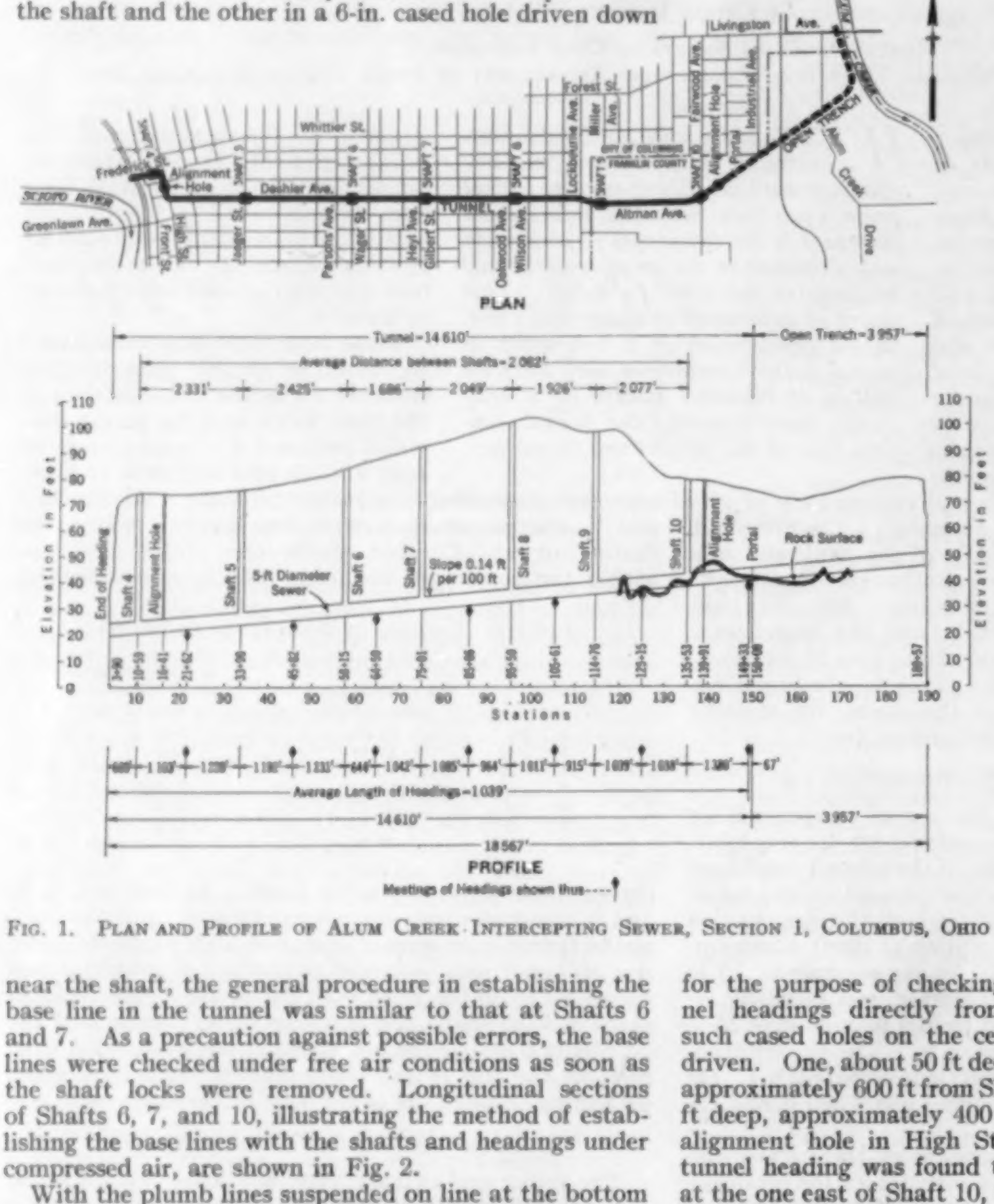


FIG. 1. PLAN AND PROFILE OF ALUM CREEK INTERCEPTING SEWER, SECTION 1, COLUMBUS, OHIO

Using the point ahead as a foresight, and with a backsight on the point to the rear as a check, a new transit point 200 ft ahead of the transit could be set. In some cases, however, particularly where higher air pressures were used, visibility was such that it was necessary to set the transit on the most advanced transit point, backsight to the next transit point to the rear, and then set points ahead by plunging and reversing the transit and taking the mean of the two points thus established. In general, visibility was satisfactory for surveying operations, but at times it was such as to make accurate surveying difficult.

At Shaft 5 there was a deflection angle of 29 min, which made it necessary to produce the line into the east heading by means of calculated tangent offsets from the line established for the west heading. On all curves, alignment was established by transit by means of chords and deflection angles.

Provision was made in the contract for the driving of cased alignment holes 8 in. in diameter, to be used for the purpose of checking the alignment in the tunnel headings directly from the surface above. Two such cased holes on the center line of the sewer were driven. One, about 50 ft deep, was located in High Street approximately 600 ft from Shaft 4, and the other, about 37 ft deep, approximately 400 ft east of Shaft 10. At the alignment hole in High Street, the center line in the tunnel heading was found to be 0.5 ft off center, while at the one east of Shaft 10, the alignment was correct.

Although the tunnel headings were under compressed air at the time the alignment holes were used, no particular difficulty was experienced on this account. At the surface, each alignment-hole casing was provided with a screw cap (or a screw plug) in which were drilled several small holes of slightly larger diameter than the No. 12 gage piano wire. With the transit set on line

TABLE II. ACCURACY OF ALIGNMENT AND ELEVATIONS OF CENTER LINE AT MEETINGS OF HEADINGS

Shaft number	4		5		6		7		8		9		10	
General direction of heading from shaft	West	East	West	East	West	East	West	East	West	East	West	East	West	East
Length of heading driven, in feet	669	1,103	1,228	1,192	1,233	644	1,042	1,085	964	1,011	915	1,039	1,038	1,380
Distance between shafts, in feet	...	2,331		2,425		1,686		2,049		1,92		2,077		...
Distance between center lines at meetings of headings, in feet: Alignment	...	0.25		0.0		0.0		0.17		0.33		0.33		0.20*
Distance between center lines at meetings of headings, in feet: Elevation	...	0.04		0.04		0.21		0.04		0.0		0.04		0.03

* Meeting of tunnel and open trench work at portal at Station 150 + 00.

on the surface, any one of these small holes could be set on line by twisting the cap.

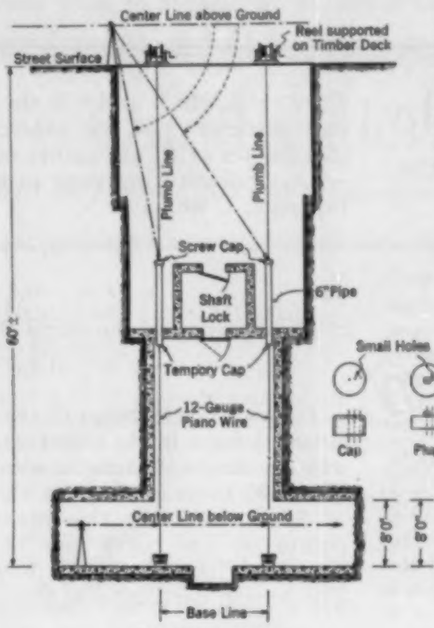
In using the alignment hole, the lower end of the casing, which projected a few inches through the roof of the tunnel heading, was capped with a plank and "mudded up" to prevent the loss of compressed air. The upper cap was then removed, and the piano wire, with a light-weight plumb bob attached, was lined in with the transit and lowered from a reel at the surface to a point just above the lower cap. Observations were then made from the surface with a flashlight, and the wire was moved either forward or backward on line until it hung free.

With the wire hanging free, its position relative to the sides of the casing was noted, after which it was reeled up and the upper cap threaded on and turned until some one of the holes in the cap was found to correspond as closely as possible to the desired position previously noted. This hole was, then marked, the cap taken off, the piano wire threaded through the marked hole, the light-weight plumb bob again attached, and the plumb bob and wire placed in the casing. The cap was then replaced on the casing and turned until the marked hole was on line. The plank cap on the lower end of the casing was then removed and the wire unreeled until it reached down into the tunnel. There the plumb bob was removed and the 44-lb lead weight attached and suspended in the bucket of water. As a final check, a flashlight beam was cast upward in the casing to make sure that the wire was still hanging free.

A bench mark was established at the bottom of Shaft 4 by means of an engineer's steel tape suspended from a point of known elevation at the surface. Bench marks at all other shafts were determined in a like manner from points of known elevation in the shaft locks. Elevations in the tunnel headings were established with a wye level, except that, at the beginning of the work, a straight edge and spirit level was used west from Shaft 7.

In Table II is shown the measured distance between center lines at the meeting of adjacent headings, for both alignment and elevation.

The work was carried out by the Division of Engineering, Department of Public Service, City of Columbus, of which R. H. Simpson, M. Am. Soc. C.E., is Chief Engineer; and John H. Gregory, M. Am. Soc. C.E., of Baltimore, Md., Consulting Engineer. The writer was in direct charge of the work. Supervision of construction as well as of surveying operations was in the charge of the Field Engineer of Sewer Tunnels, Harry Christiansen, Assoc. M. Am. Soc. C.E., from June 1929 to March 1930; and John T. More, Assoc. M. Am. Soc. C.E., from March 1930 to the completion of construction in September 1931. Construction was completed under the administration of James J. Thomas, Mayor; and W. H. Duffy and R. S. McPeak, Directors of Public Service. The tunnel was placed in operation under the present administration, Henry W. Worley, Mayor; and W. P. Halenkamp, Director of Public Service. The contractor was S. A. Healy of Detroit, Mich. Sewage began flowing through the tunnel on March 15, 1932. The total cost of construction, exclusive of engineering, was $894,550.



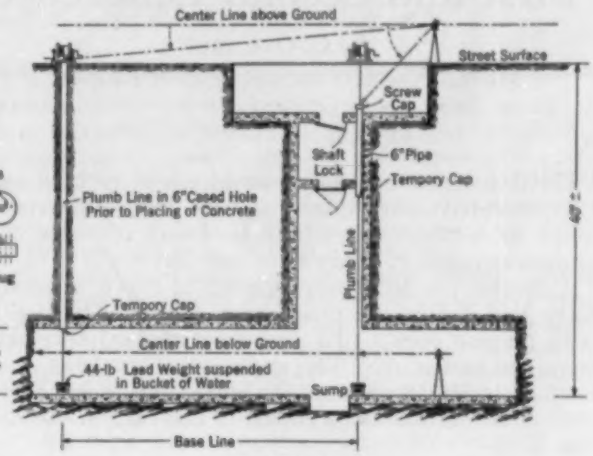


FIG. 2. METHOD OF ESTABLISHING BASE LINES IN TUNNEL
Showing Arrangement of Plumb Lines in Shaft Locks and Alignment Holes

FLOOD DELAYS CONSTRUCTION ON MADDEN DAM, CANAL ZONE

Early in December 1932, heavy, continuing rains on the watershed of the Chagres River raised that stream at the Madden Dam site 25 ft above its normal level, and sent a flood estimated at 200,000 cu ft per sec over the spillways of the Gatun Dam, situated downstream. The construction plant at the Madden Dam site was flooded and the gravel plant was somewhat damaged. The Madden Dam will increase the water supply available for locking purposes in the Panama Canal, and will act as a flood regulator on the "flashy" Chagres River.

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ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Calculating Vertical Curves by First and Second Differences

By C. O. Carey

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The method of solving problems of vertical curves presented here differs slightly from that usually given in textbooks and may be found of value to engineers engaged in highway or railroad work.

Consider the problem of a vertical curve, a parabola, to be laid out on the grade lines AV and VB, in Fig. 1, with tangent points at A and B equidistant horizontally from the vertex, V. The elevation of grade at A, Station 41, is 560.13; that at V, Station 45, is 568.53; and that at B, Station 49, is 551.33. The station distance is 100 ft.

To write an equation for the curve, assume the origin of the coordinates to be at A, with the x-axis a horizontal line through A, and the y-axis a vertical line through the same point. According to the principles of the parabola, the offsets from the tangent AV to the curve vary as the square of the distance from the tangent point, A. The offsets from the x-axis to the tangent line AV, vary as the distance from A. Then the equation of the curve may be written:

$$y = tx^2 + rx \ldots\ldots\ldots\ldots\ldots [1]$$

where t is the vertical offset from the tangent AV to the parabola at a unit distance from A, and r is the rate of grade of the tangent AV, and is plus for a rising grade and minus for a falling grade.

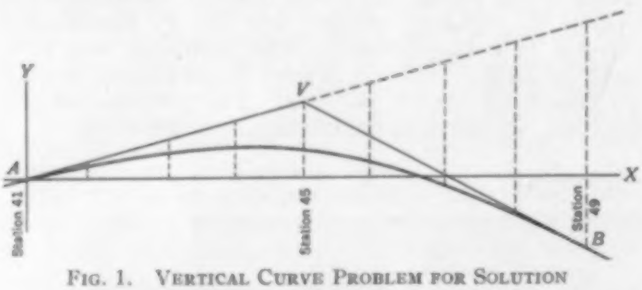


Fig. 1. Vertical Curve Problem for Solution

Since r, the rate of grade of AV, and the coordinates of the end of the curve, B, are known, the constant t can be determined by substituting their values in the equation of the curve. Vertical curves are generally extended an equal number of station distances each side of the grade vertex, and the elevations on the curve are determined for points at intervals of station distances along the curve. Any equal spacing may be used in place of station spacing.

It is convenient, therefore, for x to equal distances along the x-axis in units of station distances, or whatever equal spacing is used in laying out the curve. Then, in the example given, for Station 42, $x = 1$; for Station 43, $x = 2$, etc.; and r is the change of grade for this unit distance. In the example, $r = +2.1$, and the coordinates of B, at Station 49, are, $x = +8$, and $y = -8.8$. Substituting these in the equation of the curve, Equation 1, we have:

$$-8.8 = 64t + (2.1)(8)$$

and

$$t = -0.4$$

The equation of the curve then becomes,

$$y = -0.4x^2 + 2.1x$$

To find the elevation of the curve at Station 42, substitute 1 for x in the equation. This gives $y = +1.70$, which value, added to the elevation of A, at Station 41, gives $560.13 + 1.70 = 561.83$, the elevation of the curve at Station 42. In this manner the elevations of all points on the curve can be determined. The computations for these elevations are shown in Table I. The second derivative of the equation, $y = tx^2 + rx$, is

$$\frac{d^2y}{dx^2} = 2t \text{ (a constant)} \ldots\ldots\ldots\ldots [2]$$

The computation of the elevations of the points can be checked by finding the second differences from the elevations. The second difference in the example is $2t = -0.80$. The first and second differences are shown in the last two columns of the tabulation.

Table I. Tabular Calculation for the Vertical Curve in Fig. 1

Station	x	$-0.4x^2$	$+2.1x$	y	Elevation	First Difference	Second Difference
41	0			0	560.13		
						+1.70	
42	1	− 0.40	+ 2.10	+1.70	561.83		−0.80
						+0.90	
43	2	− 1.60	+ 4.20	+2.60	562.73		−0.80
						+0.10	
44	3	− 3.60	+ 6.30	+2.70	562.83		−0.80
						−0.70	
45	4	− 6.40	+ 8.40	+2.00	562.13		−0.80
						−1.50	
46	5	−10.00	+10.50	+0.50	560.63		−0.80
						−2.30	
47	6	−14.40	+12.60	−1.80	558.33		−0.80
						−3.10	
48	7	−19.60	+14.70	−4.90	555.23		−0.80
						−3.90	
49	8	−25.60	+16.80	−8.80	551.33		

It is evident from this analysis of the problem that the elevations at the stations on the curve can be computed from the first and second differences. In this case, the value of t is found as has been shown, and the constants of the equation of the curve are thus known. The second difference is a constant, and in the example is equal to $2t$, or -0.80. The first first difference is the value of y found by substituting 1 for x in the equation of the curve. This is $+1.70$ in the example, and when added to the elevation at the tangent point, Station 41, gives the elevation at Station 42 on the curve. The next first difference is $+1.70 - 0.80 = +0.90$. This, added to the elevation of the curve at Station 42, gives the elevation at Station 43. Thus,

each first difference is obtained by adding the constant second difference to the preceding first difference; and the elevation at each station is found by adding the computed first difference to the elevation at the preceding station.

Due regard must be given to the signs throughout the computations. The check for these computations is that the elevation obtained for the last point on the curve, Station 49 in the example, must be the same as the elevation of the grade line at that point.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Economic Justification for Single-Lane Roads

Dear Sir: I note in the letters by H. W. Skidmore and Bernard E. Gray, in the September and October issues of Civil Engineering, respectively, that there has been some misinterpretation of a few points covered in my article in the August issue. A few words concerning the more important of these points will clarify them.

Contrary to Mr. Skidmore's interpretation, the "annual road costs" computed in the article do consider all grading costs, including the unpaved second lane, as well as all necessary drainage structures. Likewise, the maintenance cost of the unpaved lane was included as well as the 9 or 10-ft paved lane. Therefore, the "annual road costs" shown include the entire cost of the project and the maintenance cost of both the paved and unpaved lanes.

In many cases, Mr. Skidmore's conclusions that "the problem resolves itself into a question of relative economy and utility between half-width expensive pavement and full-width, low-cost pavement" is undoubtedly true. The ability of a road to pay for itself by a return to the public in the form of reduced annual costs must always be considered. Load-carrying ability, however, must not be overlooked.

The Report of Investigation of Low-Cost Improved Roads, made by the Highway Research Board, gives the "annual road cost" for four types of typical low-cost roads as follows:

Method I. Feather-edge sand-clay, or clay-gravel. Followed by a mixed-in-place fine aggregate type, bituminous surface, or by a dual bituminous surface treatment.

Annual road cost $1,674

Method II. Untreated surface of gravel or macadam. Followed by mixed-in-place, bituminous-surface coarse aggregate.

Annual road cost $1,562

Method III. Bonded gravel or macadam. Followed by $1^1/_2$-in. pre-mixed bituminous top, laid cold on prime-coated base.

Annual road cost $3,507

Method IV. Traffic-bound stone, slag, or gravel. Followed by calcium chloride treatment; dual bituminous-surface treatment; and mixed-in-place, bituminous-surface coarse aggregate.

Annual road cost (dual bituminous-surface treatment) . . . $1,432
Annual road cost (mixed-in-place bituminous surface) . . . $1,530

The "annual road cost" of these four types does not include the necessary grading and drainage structures that, according to data given in the report, would amount to $200. An interest rate of 4 per cent was used instead of the $4^1/_2$ per cent used in my article.

Comparison of the "annual road cost" of each of these four low-cost types (with the "annual road cost" of $200 added but with no increase in the interest rate) with those for single-lane concrete pavements is of interest.

"Annual road cost" of four types outlined:
Minimum, $1,632; maximum, $3,707
"Annual road cost" of single-track type:
Minimum, $590; maximum, $1,050

In reference to the letter by Mr. Gray, I will not offer specific comment. The points regarding pavement life and vehicle-operating costs that Mr. Gray criticizes are the consensus of highway engineering authorities. I inspected over 780 miles of single-track concrete road in 1931 that were between 15 and 20 years old. Their condition shows clearly they will give many more years of service. In the preceding three years I inspected hundreds of miles of two-lane concrete of similar age and condition. The facts will stand on their own merits.

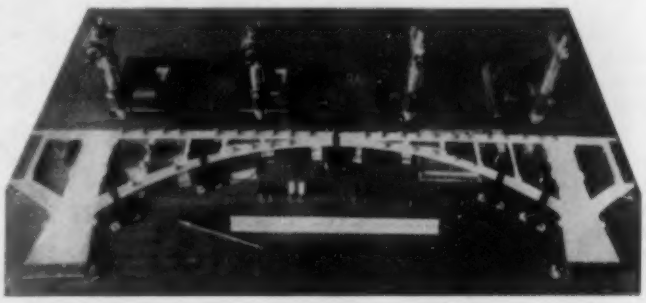
Improved highways are a perpetual charge against highway users. This charge includes first cost, yearly maintenance costs, periodic replacement costs, and the cost of their use, or vehicle-operation costs. Economic highway improvement policies dictate the building of roads that will keep this perpetual charge at a minimum, thus ensuring the construction of the maximum mileage of improved roads. The increasing recognition given this fact by leading highway engineers and administrators during the past six or seven years demonstrates its importance, which will be emphasized even more in the future.

M. D. Catton, Assoc. M. Am. Soc. C.E.
Highway Engineer

Chicago, Ill.
November 5, 1932

Examples of Deck Participation

To the Editor: Professor Finlay's paper in the November issue should be of special interest to designers of arch bridges. A recent questionnaire, sent by E. K. Timby, Jun. Am. Soc. C.E., to all state highway departments, brought out the information that at present the most general practice in designing concrete arch



A Model of the Yadkin River Bridge

bridges with spandrel columns is to use no expansion joints in the deck except at the ends of the span. It is therefore apparent that participation of the deck in live load and temperature stresses commonly occurs in bridges as now built. The advantages and disadvantages of this deck participation should be fully evaluated in the design of important concrete arch bridges, in order that the maximum advantages of deck participation may be realized and its disadvantages avoided.

In the design of the Grand Fey Viaduct, a double-track railway bridge built in Switzerland about ten years ago, full advantage of deck participation was taken in order to reduce the amount of material, thus securing economy and at the same time reducing

the foundation load, which otherwise would have been excessive. The design was governed by precise experiments on a celluloid model, from which it was possible to evaluate the stresses and deformations of all parts of the arch and continuous superstructure, and to reinforce these parts accordingly for the load and temperature stresses accompanying the complete interaction between arch and deck. Expansion joints were provided in the deck only at the ends of the 138-ft spans. Although the specified live load is heavy and the unit working stresses low according to American standards, the resulting design is impressively light in its proportions. A recent examination made by me revealed that after ten years of service no damage to the superstructure is discoverable. All the advantages of deck participation have been realized, and by carefully studied design the disadvantages of continuity have been avoided.

This project in Switzerland and other studies in America directed

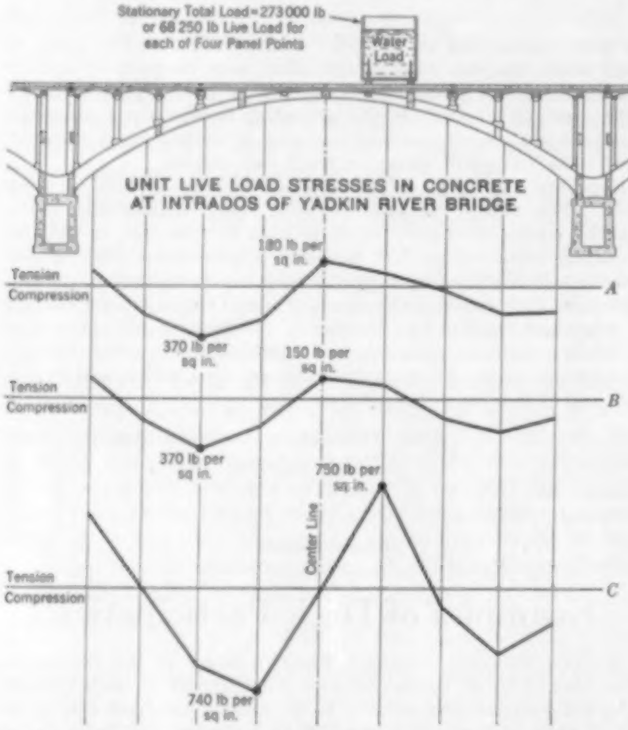


FIG. 1. UNIT LIVE-LOAD STRESSES IN CONCRETE AT INTRADOS OF YADKIN RIVER BRIDGE DUE TO TWO LOADS OF 68,250 LB PLACED AT POINTS SHOWN

Three Curves Showing Comparative Results by (A) Test of Bridge as Built, with Continuous Superstructure; (B) Prediction from Celluloid Model, with Continuous Superstructure; (C) Theory Commonly Used in Practice, Neglecting Superstructure

the attention of bridge designers to the importance of deck participation. In the years 1927–1928, the Yadkin River Bridge test was conducted, one purpose of it being to evaluate the effect of deck participation. In this connection reference is made to the Report of the U.S. Bureau of Public Roads for January 1929. A conclusion drawn from the investigation of this bridge and of its model was that the participation of the superstructure materially reduces the live-load stresses below values predicted by the commonly used theory, which neglects deck participation.

A photograph shows a model of the Yadkin River Bridge, from which stresses in the rib were predicted. In Fig. 1 are shown typical results for the unit stresses in the lower side of the arch for an unsymmetrical position of the live load, as obtained by the three methods indicated. The effectiveness of the superstructure in reducing the live-load stresses in the arch is apparent; and it appears reasonable to expect that some economy in arch design may be achieved by properly taking advantage of this favorable effect of deck participation.

GEORGE E. BEGGS, M. Am. Soc. C.E.

Princeton, N.J.
November 8, 1932

Specific Capacity of New Jersey Wells

TO THE EDITOR: In connection with the able and instructive paper entitled "New Jersey Ground-Water Supply Abundant" by Howard T. Critchlow, which appeared in the December issue, a comparison of the "specific capacities," or yield of wells, in New Jersey is of interest.

The "specific capacity" of a well is its total yield by pumping, expressed in gallons per minute, divided by the number of feet through which the water level in the well is drawn down by the pumping; that is, "specific capacity" is the gallons per minute yielded per foot of drawdown.

The "specific capacities" obtained from representative New Jersey wells on the Coastal Plain are as follows:

Raritan sand at Camden	30 to 60 gal per min per ft of drawdown
Kirkwood sand at Pleasantville . .	29 gal per min per ft of drawdown
Cohansey sand at Pleasantville . .	22 gal per min per ft of drawdown
On the Piedmont Plain:	
Triassic sandstone at E. Paterson	1.7 to 6.8 gal per min per ft of drawdown
In the Highlands:	
Pre-Cambrian igneous rock at Lake Erskine	0.6 gal per min per ft of drawdown

It has been my experience that, in order to obtain the maximum yield at the minimum cost, it is absolutely essential to obtain the services of well drillers who are thoroughly familiar with the particular geologic formations which are to be tapped. Several instances come to mind where drillers, who have been eminently successful in developing sand strata, have failed to obtain satisfactory results in rock or consolidated materials.

JOHN N. BROOKS, M. Am. Soc. C.E.
Assistant Division Engineer, New Jersey State Water Policy Commission

Trenton, N.J.
December 6, 1932

Potentialities of the Columbia River Basin

DEAR SIR: The article by Colonel Robins on "Improvement of the Columbia River," in the September issue, is of timely interest. The highest possible dam (which local engineers suggest be built in units as the market for power expands) should be constructed at, or adjacent to, tidewater where ocean-going vessels can be taken direct to the power plant. Our competitor is Norway, and we must meet the conditions and price prevailing there if we are to attract great industries serving world markets. Therefore the greatest amount of power must be concentrated at the point where production and transportation meet. This is the only point where great electric base industries can meet world-competitive price conditions, and tidewater power is the only kind of power that can be marketed for heavy industries.

Until recently, the high cost of transmitting electric power to heavy industries, compared with transporting the raw and finished products to and from such power plants by water, has not been realized. In the case of aluminum, for example, it has been estimated that $4.50 per ton of aluminum can be saved by transporting the oriental bauxite in ocean-going vessels through locks at Warrendale on the Columbia River, to the great dam at The Dalles, 45 miles distant, and taking the finished products away in similar vessels, instead of by transmitting the necessary electric power from The Dalles to great aluminum works located at Warrendale.

The weakness of the Pacific Northwest in its supply of raw materials is an advantage. We export tremendous quantities of lumber, wheat, and other farm produce and import but little. As a result, ocean carriers from foreign ports come here 92 per cent empty. In the Columbia River basin there is the richest and most extensive phosphate rock deposit in the world. There are also great deposits of iron, limestone, copper, and other mineral resources. These cannot be sold in world-competitive markets because of this one-way traffic and resulting excessive freight rates. Tramp steamers cannot afford to come here empty in

the hope of getting a return load. This tends to promote a monopoly. The ports of the Pacific Northwest are thus handicapped in comparison with Atlantic ports having two-way traffic.

The recent report of the U.S. Army Engineers shows that Florida phosphate rock can be shipped to Japan, with a handicap of one dollar per ton, through the Panama Canal more cheaply than similar Columbia River rock can be shipped less than one-half the distance from Portland, Ore. Therefore our lack of bauxite and a few necessary raw materials for a great chemical center at The Dalles is a blessing in disguise, as we will be forced to import such products from the Orient, thus affording two-way traffic for our vessels, lowering rates, and encouraging competition. This will break the monopolistic control of the coast shipping interests and establish our equality with Atlantic coast ports.

The same report indicated that millions of horse power could be had at The Dalles for about $10 per hp year with 4 per cent Federal money. This is equivalent to good black coal at about $1 per ton for the making of mixed fertilizer. All three of the elements essential for this process can be produced locally. As the world now uses more than a billion dollar's worth of mixed fertilizers a year, it can be demonstrated that, with this cheap power and reduced ocean freight rates, we can meet world-competitive conditions in this industry at least, and it should eventually reach large proportions. Phosphoric acid will become the base of a great chemical industry at The Dalles. Our rock is free from fluorine, and consequently a chemically pure, water-white acid can be produced even for the fertilizer industry. This can be shipped in tank cars or ocean tankers like oil. The new and concentrated fertilizers, containing in some cases as much as 84 per cent of plant food, will stand shipment to all parts of the world. Thus Portland may become one of the great fertilizer and chemical centers of the nation. Our farmers will then greatly benefit by reduced ocean freight rates.

John H. Lewis, Assoc. M. Am. Soc. C.E.
Consulting Engineer

Portland, Ore.
November 22, 1932

Columbia River Development Not Economically Justified

To the Editor: Colonel Robins' paper in the September issue serves to focus the spotlight once more on the much discussed Columbia River development. Comprehensive harnessing of the vast potential resources of the Columbia for power and irrigation purposes has long been the iridescent dream of the Northwest. False hopes of early realization have been unduly fostered by political demagogues and self-seeking promoters. Although the cold hard facts so concisely and admirably assembled by Colonel Robins may be somewhat disappointing to local aspirations, it is timely that the public be informed of the real situation by such an unbiased and competent authority as the Army Engineer Corps.

To those acquainted with the basin, it has been perfectly clear that the favorable physical possibilities for gigantic irrigation and hydro-electric projects constitute merely intangible assets that may become useful at some time in the future. Additional development under present conditions is not within the bounds of economic practicability. As pointed out by Colonel Robins, the irrigation projects would require greater outlay than the land could bear, and subsidies from the depleted public treasury to still further increase the already over-expanded irrigated acreage of the West are out of the question.

The entire region is already well supplied with electric power from existing facilities, and it is evident that new hydro-electric projects of the great magnitude proposed would have to depend largely upon the development of new markets in the industrial field. Even at the relatively low costs of production which might possibly be achieved, the prospects in this direction are not promising. Authoritative studies conducted during the past five years by both Government and private agencies in connection with several of the most favorably situated projects have failed to disclose attractive conditions for large electro-chemical or electro-metallurgical works.

Aside from the complex physical and economic problems involved, numerous other obstacles must be faced. Not the least of these will be the question of interference with the famous Columbia salmon run on which an extensive industry is dependent. This comprised one of the most vexing problems we encountered in connection with the comparatively low dam recently constructed at Rock Island, and the matter will be much more serious with higher dams and at sites lower down on the river.

Under all circumstances, it may be safely concluded that further developments on the Columbia will be long delayed, and doubtless the material presented by Colonel Robins will be helpful in ending, for a time at least, fruitless discussion and agitation about immediate development.

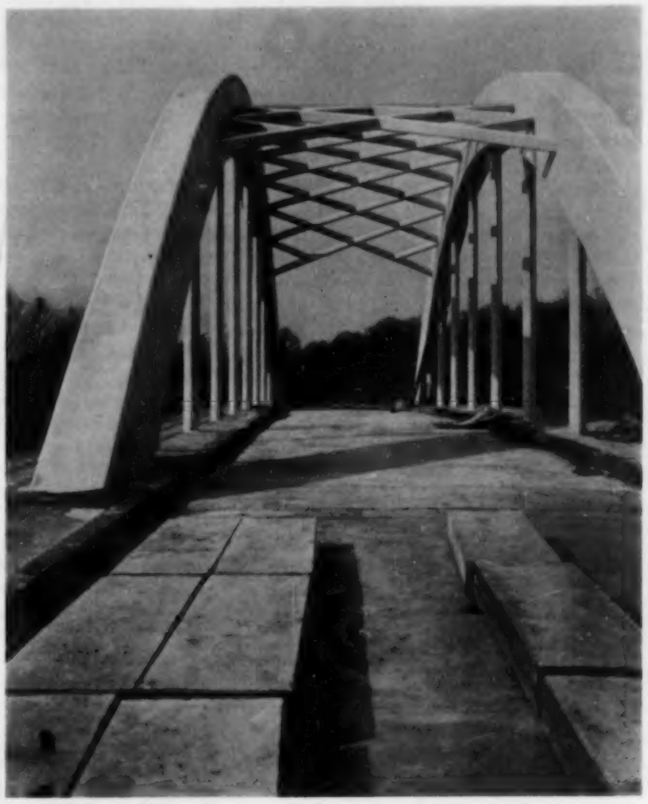
Frank E. Bonner, M. Am. Soc. C.E.
Consulting Engineer

Piedmont, Calif.
November 10, 1932

Tied-Arch Highway Bridges Favored

Dear Sir: The account given by Mr. McCullough, in the September issue, of bow-string arches as used on the Pacific coast in America, recalls our own experience with this type.

We have built six similar tied-arch highway bridges with spans of 158, 178, 194, 210, and 225 ft. The wind bracing of Mr. McCullough's and our structure is of the same type, as will be evident from the photograph presented herewith. We consider this type as most suitable for our bridges, although as far as we know it has not been used much for concrete arches.



Tied-Arch Highway Bridge Construction in the Netherlands

This type of bridge proves to be economical in the Netherlands, and therefore we expect to build many more similar structures. In addition it has the virtue of a good appearance.

C. F. van Bergen
Chief Engineer, Reinforced Concrete Division
Highway Bridge Department of the Netherlands

'S-Gravenhage, Netherlands
November 14, 1932

Ground-Water Reservoirs Important

TO THE EDITOR: The article by Mr. Critchlow in the December issue, on the ground-water resources of New Jersey, is of considerable interest. The drought of 1930–1931 brought an acute realization of the general inadequacy throughout the country of both municipal and industrial supplies, as now developed. The reason why this drought was felt so widely was not wholly because of its severity. An important reason was that the demand for water had increased vastly even since 1910, which was also an outstanding drought year. Studies of available data indicate that any section of the country may have a drought approaching in severity that of 1930–1931 at intervals so close together that supplies must be planned to provide for shortages as great as occurred at that time.

The extent to which ground water can be developed will depend ultimately on the recharge of the underground reservoirs. There are, of course, large reservoirs of underground water that will act for some time as a reserve if the rate of demand exceeds that of recharge. A persistent lowering of the ground-water table indicates that the demand is greater than the safe yield and that ultimately it will be necessary to seek additional sources of supply.

In the earlier ground-water developments, adequate quantities were usually obtained from shallow sources. In many localities, however, increased demands have lowered the ground-water table or reduced the artesian head to a point where these sources of supply have become inadequate. Such shortages have been overcome by deepening the wells or increasing the pumping capacity in many instances where the ground-water reservoir was sufficient to contribute additional water. Such measures are effective only as long as the safe yield of the ground-water reservoir is not exceeded. In areas having large underlying ground-water reservoirs, drought years have but little effect on the water supplies obtained from wells, largely because of the storage capacity of the reservoirs. This fact was illustrated during the drought of 1930–1931, when there was no shortage in the supplies at Atlantic City, N.J., Memphis, Tenn., and other cities that tap large ground-water reservoirs.

Except in limestone or other channeled or creviced rock, ground waters are not generally subject to pollution to the same extent as surface waters. It is seldom that pollution occurs except at the water table, and a drilled well properly cased to a considerable depth below the water table, or into an artesian formation, will generally yield safe water. The possibility of contamination by salt water or other highly mineralized water must also be taken into account in some localities where there is a great concentration of draft from the ground-water reservoir as a result of heavy pumping from many wells situated in a relatively small area.

A factor that is usually of prime importance in planning for ground-water development is the fluctuation of the water table in the past. Unfortunately, comparatively few records of such fluctuation have been collected over any extended period. The importance of these data apparently has not been fully appreciated, at least not to the point of making systematic studies on the same basis as those for surface water. Records of the fluctuation of ground-water levels are basic for all detailed studies of this source and should be collected in the same systematic way as data on stream flow. The securing of such records is a governmental function in which the nation, state, and community are interested, and each community should provide through its local administration agency for the collection of these data in cooperation with state and Federal agencies.

JOHN C. HOYT, M. Am. Soc. C.E.
Hydraulic Engineer
Surface Water Division, U.S. Geological Survey

Washington, D.C.
Dec. 6, 1932

A Famous Bamboo Bridge

DEAR SIR: On page 1 of CIVIL ENGINEERING for November you show a picture of "An Unusual Bridge." The subtitle goes on to say that the "Details of location and construction are not known."

A picture of the same bridge is given on page 421 of a book entitled *Exploring for Plants*, by David Fairchild. The subtitle there reads: "The famous bamboo bridge of Bandjar Negara in Central Java. It is a suspension bridge built entirely of bamboo with the exception of four large corner posts."

This is a closer view than that reproduced in CIVIL ENGINEERING and shows the bridge from a different angle, so that the details of construction are more readily seen than in your picture.

GEORGE I. GAY, Assoc. M. Am. Soc. C.E.

Palo Alto, Calif.
November 18, 1932

The City Planner's Responsibility

TO THE EDITOR: The articles by Messrs. Black and Arneson, published in the symposium, "The Practical City Plan," in the December issue, open up an interesting field for thought and discussion. From the standpoint of the municipal engineer, who is often called upon to act in the field of city planning, either independently or in collaboration with a planning specialist, there is a great deal of food for reflection in Mr. Black's presentation of the subject.

I believe that the government of a municipality should be conducted with the same degree of thoroughness that would be expected in the case of a sound business venture of similar magnitude. A commercial or manufacturing establishment or a public utility corporation which does not plan carefully for the future is not apt to expand as it should. A municipality governed, as many unfortunately are, with a surprising lack of vision, cannot be expected to have an orderly growth. It may increase in population, even at an abnormal rate. But if its territorial expansion is not properly controlled; if its recreational facilities are not developed to keep up with its increase in population; if its transportation and utility services are not expanded; if its traffic arteries become choked; and if the esthetic elements of beauty and symmetry are neglected, it will gradually become less and less desirable as a place in which to live, and its rate of growth must necessarily fall off.

Regardless of whether or not a city has a municipal planning commission or whether or not it employs a planning consultant, the municipal authorities and the public should be made to see the advantages of certain basic surveys. It is hardly necessary to point out to a group of engineers the advantages of a triangulation net, of lines of precise traverse, or of a first-order level system. Neither is it necessary to discuss the good points of an accurate topographic map.

The layman, however, has naturally only a hazy conception of what such work is supposed to accomplish. It is squarely up to the engineer to clarify the situation and show the city authorities and the taxpayers the advantages of basic surveys.

A study of Mr. Arneson's interesting paper has also brought to mind a few thoughts that may be timely. The center of the life of our people is the home. It does not seem unreasonable therefore to say that the central axis, or hub, about which the rest of the plan revolves, is the planning of residential districts, not only for the more affluent citizens, but more especially for the great bulk of the populace—the clerk, the laborer, and the factory worker.

Much will have been accomplished in the attempt to solve the numerous social and welfare problems confronting our cities today if we can, by the exercise of foresight, plan cities so that their facilities for the enjoyment of life are utilized to the fullest extent. How much more pleasant cities will seem if citizens are given the opportunity to rent, purchase, or build their homes amid pleasant surroundings, with the benefit of sunshine, fresh air, and natural beauty, where their children can grow up away from the physical dangers of congested traffic and the many less apparent, but none the less dangerous, influences incident to the cramming of large masses of people into the squalid surroundings of tenement and apartment districts!

ROSCOE N. CLARK, M. Am. Soc. C.E.
City Engineer

Hartford, Conn.
December 8, 1932

Eightieth Annual Meeting

Program of Sessions, Entertainment, and Trips
New York—January 18-21, 1933

Business Meeting, Prize Awards, and Committee Reports

WEDNESDAY—January 18, 1933—Morning

AUDITORIUM

9:00 **Registration**

10:00 **Eightieth Annual Meeting called to order by**

HERBERT S. CROCKER, *President Am. Soc. C.E., Consulting Engineer*, Denver, Colo.

10:10 **Report of the Board of Direction**
Report of the Secretary
Report of the Treasurer

10:35 **Conferring of Honorary Membership**

LINCOLN BUSH, *Past-President Am. Soc. C.E., Consulting Engineer*, East Orange, N.J. Colonel Bush will be presented to the President by A. N. TALBOT, *Past-President and Honorary Member Am. Soc. C.E., Professor Emeritus, College of Engineering, University of Illinois*, Urbana, Ill.

J. E. GREINER, *M. Am. Soc. C.E., Consulting Engineer*, Baltimore, Md. Mr. Greiner will be presented to the President by FRANCIS LEE STUART, *Past-President, Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

CHARLES L. STROBEL, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill. Mr. Strobel will be presented to the President by C. F. LOWETH, *Past-President Am. Soc. C.E., Chief Engineer, Chicago, Milwaukee, St. Paul and Pacific Railroad*, Chicago, Ill.

Members of the Society in the Metropolitan District are to be hosts to those who travel to New York to attend the Seventy-Ninth Annual Meeting, January 18–25. Careful plans have been laid to provide for the material comfort and intellectual interests of all members and guests in attendance. From the time the outgoing Board of Direction completes its 1932 business, on Tuesday, January 17, until the last inspection trip on Saturday, there is planned a continuous sequence of events, that will keep all in attendance comfortably busy.

11:00 **Presentation of Medals and Prizes**

The J. James R. Croes Medal to DAVID L. YARNELL, *M. Am. Soc. C.E., Senior Drainage Engineer, Bureau of Public Roads, United States Department of Agriculture*, Iowa City, Iowa, and FLOYD A. NAGLER, *M. Am. Soc. C.E., Professor of Hydraulic Engineering, University of Iowa*, Iowa City, Iowa, for Paper No. 1778, "Effect of Turbulence on the Registration of Current Meters."

The James Laurie Prize to EARL I. BROWN, *M. Am. Soc. C.E., Colonel, Corps of Engineers*, U.S.A., *United States Engineer Office*, Philadelphia, Pa., for Paper No. 1777, "The Chesapeake and Delaware Canal."

The Thomas Fitch Rowland Prize to CLIFFORD ALLEN BETTS, *M. Am. Soc. C.E., Engineer, U.S. Bureau of Reclamation*, Ontario, Ore., for Paper No. 1771, "Completion of Moffat Tunnel of Colorado."

The Arthur M. Wellington Prize to FRED LAVIS, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y., for Paper No. 1783, "Highways as Elements of Transportation."

The Collingwood Prize for Juniors to ARTHUR R. C. MARKL, *Assoc. M. Am. Soc. C.E., Civil Engineer*, New York, N.Y., for Paper No. 1775, "The Shannon Power Development in the Irish Free State."

11:30 **Presentation of Reports of Committees**

COMMITTEEE ON CONCRETE AND REINFORCED CONCRETE

CLYDE T. MORRIS, *M. Am. Soc. C.E., Professor of Structural Engineering*, Ohio State University, Columbus, Ohio, *Chairman*.

COMMITTEE ON EARTHS AND FOUNDATIONS

LAZARUS WHITE, *M. Am. Soc. C.E., President, Spencer, White, and Prentis, Inc.*, New York, N.Y., *Chairman*.

COMMITTEE ON IRRIGATION HYDRAULICS

J. C. STEVENS, *M. Am. Soc. C.E., Consulting Engineer*, Portland, Ore., *Secretary*.

COMMITTEE ON METEROLOGICAL DATA

DONALD M. BAKER, *M. Am. Soc. C.E., Consulting Engineer*, Los Angeles, Calif., *Chairman*.

COMMITTEE ON STEEL COLUMN RESEARCH

F. E. TURNEAURE, *M. Am. Soc. C.E., Consulting Engineer; Dean, College of Mechanics and Engineering, University of Wisconsin*, Madison, Wis., *Chairman*.

COMMITTEE ON STRESSES IN RAILROAD TRACK

A. N. TALBOT, *Past-President and Honorary Member Am. Soc. C.E., Professor Emeritus, College of Engineering, University of Illinois*, Urbana, Ill., *Chairman*.

12:00 **New Business**
Report of Tellers on Canvass of Ballot for Officers
Introduction of President-Elect

12:30 **Luncheon**

Fifth Floor, Engineering Societies Building. Tickets $1.00 each.

Use Railroad Certificate to Obtain Reduced Fare. Consult Your Ticket Agent for Selling Date in Your Territory

General Session—President's Reception and Dance

WEDNESDAY—January 18, 1933—Afternoon

AUDITORIUM

A SYMPOSIUM
DEALING WITH LONG-RANGE PLANNING, THE FUTURE OF BUSINESS, INTERNATIONAL RELATIONS, RAILWAY PROBLEMS

In such times as the world now is going through, an Annual Meeting of the Society would not be complete without devoting a general meeting to a consideration of causes, resulting problems, and possible solutions for our economic ills. A better understanding of the confused problems of today will result from a consideration of these papers, each to be presented by an expert in his field.

2:15 Long Range Planning and the Future of Business

DAVID FRIDAY, *Esq., Economist*, Washington, D.C.

3:00 International Relations

FRED I. KENT, *Esq., Director, Bankers Trust Company; Chairman, Commerce and Marine Committee of the American Bankers Association*, New York, N.Y.

3:40 Some of the Problems of the Railroads

R. E. DOUGHERTY, *M. Am. Soc. C.E., Vice-President, New York Central Lines*, New York, N.Y.

REGIONAL MEETING COMMITTEE

This program has been prepared under the direction of the Regional Meeting Committee: Arthur S. Tuttle, Vice-President Am. Soc. C.E., Chairman; and Leslie G. Holleran, Charles A. Mead, and Ole Singstad, Directors Am. Soc. C.E.

WEDNESDAY—January 18, 1933—Evening

DINNER AND DANCE COMMITTEE: EDWARD ANDERBERG, CHAIRMAN, WILLIAM J. SHEA, EMIL PRAEGER

THE PRESIDENT'S AND HONORARY MEMBERS' DINNER, RECEPTION, AND DANCE

7:00 Assembly

7:30 Dinner

9:30 Reception to the President and Honorary Members

10:00 Dancing

This function will be held at the Hotel Roosevelt, Madison Avenue and 45th Street, the Grand Ball Room to open at 7:00 p.m. and the dinner to be served promptly at 7:30 p.m.

Arrangements have been made for tables seating ten persons, and members may underwrite complete tables. Orders to underwrite a table must be accompanied by check in full, and a list of guests.

The seating list will close at 5:00 p.m. Tuesday, January 17, 1933. Those who purchase tickets after 5:00 p.m., January 17, will be assigned to tables in the order of their purchase. Tickets will be on sale at Society Headquarters until 5:00 p.m., Wednesday, January 18, 1933.

Tickets will be $5.00 each. Tickets for Juniors for the dance only will be $2.00 per couple.

All who attend the Annual Meeting are requested to register immediately upon their arrival at the Engineering Societies Building. Badges and tickets for all functions should be obtained at the Registration Desk on the main floor.

HACKENSACK RIVER CROSSING OF THE DIAGONAL BRIDGE, NEW JERSEY EXPRESS HIGHWAY

Sessions of Technical Divisions Occupy Full Day

THURSDAY—January 19, 1933—Morning

SESSIONS OF TECHNICAL DIVISIONS
HIGHWAY DIVISION

10:00 Cost of Delays

S JOHANNESSON, *M. Am. Soc. C.E., Designing Engineer, State Highway Commission*, Jersey City, N.J.

10:40 Control of Pavement Cuts with Reference to Washington Practice

H. C. WHITEHURST, *M. Am. Soc. C.E., Director of Highways, District of Columbia*, Washington, D.C.

11:20 Control of Pavement Cuts with Particular Reference to New York City Practice

R. A. MACGREGOR, *M. Am. Soc. C.E., Engineer of Maintenance, Borough of Manhattan*, New York, N.Y.

THURSDAY—January 19, 1933—Morning

STRUCTURAL DIVISION

10:00 Report of Subcommittee on Wind Bracing in Tall Buildings

C. R. Young, *M. Am. Soc. C.E., Professor, Civil Engineering, University of Toronto,* Toronto 5, Ontario, Canada, *Chairman.*

Report of Subcommittee on Structural Alloy and Heat Treated Steels

Robert S. Johnston, *M. Am. Soc. C.E., Director of Research, John A. Roebling's Sons Company,* Trenton, N.J., *Chairman.*

11:30 Wind Stress Analysis Simplified

L. E. Grinter, *Assoc. M. Am. Soc. C.E., Professor, Structural Engineering, Agricultural and Mechanical College of Texas,* College Station, Tex.

SANITARY ENGINEERING DIVISION

10:00 The Manufacture and Control of Liquid Alum at Montebello Filters

J. W. Armstrong, *M. Am. Soc. C.E., Filtration Engineer, Baltimore City Water Department,* Baltimore, Md.

10:20 Discussion by

J. E. Curtis, *M. Am. Soc. C.E., Senior Engineer, Dalecarlia Filter Plant,* Washington D.C.

T. D. Samuel, Jr., *M. Am. Soc. C.E., Chief Engineer and Superintendent, City Water Department,* Kansas City, Mo.

F. W. Green, *Esq., Superintendent of Filtration and Dumping,* Little Falls, N.J.

Harry N. Jenks, *M. Am. Soc. C.E., Consulting Sanitary Engineer,* Berkeley, Calif.

10:40 Deep Tunnel Delivery of Water Supply for Large Cities

Walter E. Spear, *M. Am. Soc. C.E., Department Engineer, Board of Water Supply,* New York, N.Y.

11:00 Discussion by

William W. Brush, *M. Am. Soc. C.E., Chief Engineer, Bureau of Water Supply, Department of Water Supply, Gas, and Electricity,* New York, N.Y.

Thomas H. Wiggin, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

11:20 Formation of Floc with Ferric Salts

Edward Bartow, *M. Am. Soc. C.E., Professor and Head, Department of Chemistry and Chemical Engineering, University of Iowa,* Iowa City, Iowa; A. P. Black, *Esq., Professor of Agricultural Chemistry, University of Florida,* Gainesville, Fla.; and Walter E. Sansbury, *Esq., Fellow in Chemistry, University of Florida,* Gainesville, Fla.

11:40 Discussion

W. D. Hatfield, *Assoc. M. Am. Soc. C.E., Superintendent, Sewage Disposal Plant,* Decatur, Ill.

Edward S. Hopkins, *Esq., Chemical Engineer, Chief Chemist and Director of Research, Bureau of Water Supply, Montebello Filters,* Baltimore, Md.

L. H. Enslow, *Assoc. M. Am. Soc. C.E., Sanitary Engineer, The Chlorine Institute, Inc.; Editor, "Water Works and Sewerage,"* New York, N.Y.

12:00 Status of Wards Island Sewage Treatment Works

Richard H. Gould, *M. Am. Soc. C.E., Engineer in Charge, Sewage Disposal and Intercepting Sewers, Department of Sanitation,* New York, N.Y.

12:20 Presentation of Reports

Montebello from the Tower of the New Filtration Plant, Baltimore, Md.

Railroad Grade Separation, Clifton, N.J.
Delaware, Lackawanna, and Western Railroad

THURSDAY—January 19, 1933—Afternoon

CITY PLANNING DIVISION

2:30 Equitable Distribution of Assessments for City Planning Projects

Hyman Shifrin, *M. Am. Soc. C.E., Assistant Chief Engineer, Division of Sewers and Paving, Department of the President, Board of Public Service,* St. Louis, Mo.

Discussion by

Herman H. Smith, *M. Am. Soc. C.E., Chief Engineer, Board of Estimate and Apportionment,* New York, N.Y.

G. G. McCaustland, *M. Am. Soc. C.E., City Plan Engineer, City Plan Commission,* Kansas City, Mo.

George H. Herrold, *M. Am. Soc. C.E., Managing Director and Engineer, The City Planning Board,* St. Paul, Minn.

Oliver D. Keese, *Assoc. M. Am. Soc. C.E., Office Engineer, Office of County Surveyor,* Los Angeles, Calif.

Philip H. Cornick, *Esq., Institute of Public Administration, Inc.,* New York, N.Y.

THURSDAY—January 19, 1933—Afternoon (continued)

CONSTRUCTION DIVISION—STRUCTURAL DIVISION

JOINT SESSION

2:30 The New Jersey Express Highway

H. W. HUDSON, *M. Am. Soc. C.E., Engineer in Charge of Construction, State Highway Commission*, Jersey City, N.J.

3:00 Construction of Railroad Grade Separation

G. H. WILSEY, *M. Am. Soc. C.E., Engineer, Foley Brothers, Inc.*, New York, N.Y.

3:30 Structural Design for Railroad Grade Separations

JOHN L. VOGEL, *M. Am. Soc. C.E., Bridge Engineer, Delaware, Lackawanna, and Western Railroad*, Hoboken, N.J.

4:00 Discussion

WATERWAYS DIVISION

2:30 What Are Navigable Waters of the United States?

G. B. PILLSBURY, *M. Am. Soc. C.E., Brigadier-General, Corps of Engineers, U.S.A., Assistant Chief of Engineers, U.S.A.*, Washington, D.C.

Discussion by

C. W. KUTZ, *M. Am. Soc. C.E., Brigadier-General, U.S.A. (Retired)*, Washington, D.C.

JOHN F. COLEMAN, *Past-President Am. Soc. C.E., J. F. Coleman Engineering Company*, New Orleans, La.

207TH STREET YARDS, INDEPENDENT SUBWAY SYSTEM, NEW YORK
For Storage, Inspection, and Repair. Capacity 600 Cars

INLAND TERMINAL NO. 1, NEW YORK CITY
A Port of New York Authority Project

Entertainment for Ladies—Smoker for Men

THURSDAY—January 19, 1933—Afternoon and Evening

ENTERTAINMENT FOR THE LADIES

LADIES COMMITTEE: MRS. CHARLES E. TROUT, CHAIRMAN, MRS. WILLIAM McK. GRIFFIN, MRS. FREDERICK C. NOBLE, AND MRS. WILLIAM J. SHEA, VICE-CHAIRMEN.

3:00 Visit to Roosevelt House, 28 East 20th Street, the birthplace of Theodore Roosevelt

Roosevelt House has been restored by the Woman's Roosevelt Memorial Association. In addition to the rooms furnished in the period of Roosevelt's time, the house contains museums in which are exhibited decorations, souvenirs, cartoons, and other memorabilia of Theodore Roosevelt, which exhibits will be on display.

Tea will be served from 3:00 to 6:00 p.m.

Mrs. Douglas Robinson, sister of the late President Roosevelt, will be present to meet the ladies and to address them.

Through the courtesy of the Engineering Woman's Club, Inc., 123 East 37th Street, the facilities of that club will be available to the ladies during the entire Annual Meeting.

All ladies are especially invited to make the club their headquarters. Members of the Ladies Committee will be at the club to assist visiting ladies in getting acquainted, and to furnish information about shopping, sightseeing, or other matters of interest.

There will be an information desk for ladies at Society Headquarters, and all ladies are requested to avail themselves of the facilities of the Society or the Engineering Woman's Club.

8:00 Social Evening and Entertainment

The ladies will be entertained at the Engineering Woman's Club. All ladies are invited to attend. The Ladies Committee will be the hostesses.

THURSDAY—January 19, 1933—Evening

AUDITORIUM

COMMITTEE: ALBERT B. HAGER, CHAIRMAN; BILLINGS WILSON AND DAVID BONNER

8:00 Address and Smoker
Illustrated Address by Bernt Balchen on the Byrd Antarctic Expedition

The Society is fortunate in being able to schedule Bernt Balchen for an address on the Byrd South Pole expedition. His exploits and experiences in the air are well known to every American. He was one of the pilots on the transatlantic flight of Commander Byrd and was Byrd's pilot on the flight over the South Pole.

At the close of the address, there will be a Smoker on the fifth floor.

For those who may not care to smoke or who may wish to visit quietly with friends, a continuous entertainment, consisting of interesting motion picture films interspersed with music, will be provided in the auditorium. Tickets for the Smoker and evening's entertainment are free to members. Guest tickets are $2.00 each.

Sanitary Engineers' Annual Meeting and Dinner

TUESDAY—All Day

New York State Sewage Works Association Annual Meeting

The New York State Sewage Works Association will hold its Annual Meeting on Tuesday, January 17, 1933, at the Hotel McAlpin, New York, N.Y. The meeting will comprise a morning session, a luncheon, and an afternoon session. In the evening the members will meet jointly with the Sanitary Engineering Division of the Society at its Annual Dinner at the Hotel McAlpin. Of special interest to the sanitary engineers, the afternoon session is to be devoted to a general symposium on the new chemical precipitation process for sewage treatment.

TUESDAY—Evening

Annual Dinner of the Sanitary Engineering Division

The Annual Dinner of the Sanitary Engineering Division of the Society will be held on Tuesday, January 17, 1933, at 7:30 p.m., at the Hotel McAlpin, Broadway and 34th Street, New York, N.Y. Interesting motion pictures of various German sewage treatment works will be shown by Stanton L. Dorsey, Esq. The charge per cover will be $3.00. Reservations should be made not later than January 13, 1933, through Richard H. Gould, M. Am. Soc. C.E., Department of Sanitation, 54 Lafayette Street, New York, N.Y.

Engineering College Alumni Meetings

THURSDAY

DINNER OF COLUMBIA ENGINEERS

The graduates of Columbia University who are members of the Society will meet for an informal dinner on Thursday, January 19, 1933, at 6:15 p.m., at the Columbia University Club, 4 West 43d Street, New York, N.Y. The charge will be $1.50 per cover. Address communications to J. K. Finch, M. Am. Soc. C.E., Renwick Professor of Civil Engineering, Columbia University, New York, N.Y.

UNIVERSITY OF ILLINOIS ENGINEERS DINNER

All University of Illinois engineers, and their friends, are invited to the Fifth Annual Informal Dinner-Reunion at Rosoff's Restaurant, 147 West 43d Street, New York, N.Y., on Thursday, January 19, 1933, at 5:45 p.m. in the Oxford Room.

The dinner will cost 65 cents and will be over in time for guests to attend the Society's Smoker. If you plan to attend, please notify Martin E. Jansson, Care, D. Van Nostrand Company, Publishers, 250 Fourth Avenue, New York, N.Y.

LAFAYETTE COLLEGE CIVIL ENGINEERS DINNER

All civil engineers of Lafayette College are invited to attend an informal dinner on Thursday, January 19, 1933, at 6 p.m. in the Grill Room of the Happiness Restaurant, 6 East 39th Street, New York, N.Y. The charge will be $1.50 per cover. If you plan to attend, please notify William R. Wolff, 2 Adrian Avenue, New York, N.Y.

UNIVERSITY OF PENNSYLVANIA CIVIL ENGINEERS DINNER

The Fourteenth Annual Informal Dinner of the University of Pennsylvania Civil Engineers will be held at the Pennsylvania Club, 35 East 50th Street, New York, N.Y., on Thursday, January 19, 1933, from 6:00 to 7:30 p.m. The dinner fills in the time from the end of the Technical Session at 5:00 p.m., until the commencement of the Smoker at 8:00 p.m. Dinner will be served at 6:00 p.m. sharp, in the main dining room of the club.

The charge per cover will be $1.10. Any further information can be obtained from William G. Grove, M. Am. Soc. C.E., Care, Robinson and Steinman, Room 1104, 117 Liberty Street, New York, N.Y.

FRIDAY

BROWN ENGINEERING ASSOCIATION

The Brown Engineering Association will hold its Nineteenth Annual Dinner Meeting at the Brown Club, Hotel Wentworth, 59 West 46th Street, New York, N.Y., on Friday evening, January 20, 1933, at 6:30 p.m. Dr. Clarence A. Barbour, President of the University, will be the principal speaker. All Brown alumni are invited. The charge will be $1.50 per cover. Please notify the Brown Club (telephone, Bryant 9-0310) as to attendance.

CORNELL DINNER

There will be an informal dinner meeting with news from the campus for visiting Cornell engineers and local members of the Cornell Society of Engineers, on Friday, January 20, 1933, at 6:30 p.m., at the Cornell Club of New York, 245 Madison Avenue, New York, N.Y. Please notify E. C. M. Stahl, 380 Pearl Street, Brooklyn, N.Y., of your intention to be present.

HARVARD-YALE-PRINCETON SMOKER

The 1933 Joint Meeting of the Harvard Engineering Society and the Yale and Princeton Engineering Associations will be held on Friday evening, January 20, 1933. The Princeton Engineering Association will be host for the evening. The meeting will be held at the Princeton Club, 39 East 39th Street, New York, N.Y., and an interesting program has been arranged for the evening. Members of these societies in the Metropolitan District and from out of town are invited to be present, and they are assured of a very enjoyable time. No charge will be made.

SYRACUSE UNIVERSITY ALUMNI DINNER

Graduates and former students of the College of Applied Science, Syracuse University, will hold a dinner at the "Old Algiers," 2674 Broadway, corner 102d Street, New York, N.Y., at 6:30 p.m., Friday, January 20, 1933. Reservations at $1.00 per plate may be secured by writing Stan F. Yasines, Jun. Am. Soc. C.E., Instructor in Civil Engineering, New York University, University Heights, New York, N.Y.

THAYFR SOCIETY OF ENGINEERS OF DARTMOUTH COLLEGE

The Annual Meeting and Dinner of the Thayer Society of Engineers of Dartmouth College will be held at the Dartmouth College Club, New York, N.Y., at 6:30 p.m., Friday, January 20, 1933. Notify the Dartmouth College Club, 24 East 38th Street, New York, N.Y., as to attendance.

SATURDAY

CLARKSON COLLEGE ALUMNI DINNER MEETING

The Annual Dinner and Business Meeting of the Clarkson College Alumni Association will be held at the Hotel McAlpin, New York, N.Y., on Saturday, January 21, 1933. The business meeting will be held in Room E at 2:00 p.m., to which all alumni members are invited. The dinner will be held in the Blue Room at 6:30 p.m. The charge per cover will be $4.00. Notify Frank C. Boes, M. Am. Soc. C.E., 38 Cypress Street, Floral Park, N.Y., as to attendance.

All Day Excursion to West Point

Luncheon and Winter Sports Provided at Bear Mountain

FRIDAY—January 20, 1933—All Day

10:00 All-Day Excursion

By special train to West Point, with stop at Bear Mountain.

EXCURSION COMMITTEE: E. R. NEEDLES, CHAIRMAN; WILLIAM L. HANAVAN AND MONTGOMERY B. CASE

Through the courtesy of MAJOR-GENERAL WILLIAM D. CONNOR, *U.S.A., Superintendent of the U.S. Military Academy,* arrangements have been made for a visit to West Point.

The party will go by special train on the West Shore Railroad, the schedule of the trip being as follows:

Leave New York via Cortland Street Ferry of West Shore Railroad . . . . 9:15 a.m.

Leave New York via 42d Street Ferry of West Shore Railroad . . . . .9:40 a.m.

Leave Weehawken, N.J., via West Shore Special . . .10:00 a.m.

Arrive West Point . . 11:00 a.m.

Memorial Service in Cadet Chapel to the late JOHN R. SLATTERY, *M. Am. Soc. C.E.* . 11:30 a.m.

Inspection of Academy Grounds and Buildings. 12:00 m.

Leave West Point via West Shore Special . . 1:10 p.m.

Arrive Bear Mountain . . . . 1:20 p.m.

Leave Bear Mountain via West Shore Special . 3:25 p.m.

Arrive Weehawken, N.J. . . . . 4:30 p.m.

Arrive New York via 42d Street Ferry . . . 4:45 p.m.

CADET CHAPEL, WEST POINT

On arrival at West Point, the party will go directly to the Cadet Chapel, where the memorial service in honor of the late JOHN R. SLATTERY, *M. Am. Soc. C.E.*, will be conducted by the Academy Chaplain, assisted by the Chapel Organist.

At the close of the memorial service, the party will be conducted to points of interest by officers designated by the Superintendent of the Academy. There will be opportunity to see the section rooms, where the cadets are given instruction, and the barracks, mess hall, gymnasium, museum, etc.

The party will leave West Point via the West Shore Railroad on the special train at 1:10 p.m., and arrive at Bear Mountain at 1:20 p.m., where luncheon will be served promptly at the Bear Mountain Inn.

Following luncheon, those who desire may participate in winter sports. A large ice-skating rink adjoins the inn and members of the party who wish to take advantage of the rink should bring their skates. Toboggans and skis can be rented for a small fee. Those who do not wish to engage in skating or other winter sports, may enjoy the delightful facilities of the inn for visiting and renewing acquaintanceships.

Tickets for the excursion, including round-trip railroad fare and luncheon, are $3.50 each.

WINTER SPORTS AT THE BEAR MOUNTAIN INN

INDOOR SKATING RINK, BEAR MOUNTAIN INN

Trips to Engineering Works of Interest

SATURDAY—January 21, 1933—Morning

10:00 Inspection Trips

Arrangements have been made for visits to the following points of engineering interest. As these trips all start about the same hour, it will not be possible to participate in more than one. Members will proceed individually to the rendezvous point named for the trip selected, so as to arrive at the time given.

1. Wards Island Sewage Treatment Works
2. Eighth Avenue Subway
3. Westchester County Parkway Developments
4. Transatlantic Pier Terminal
5. Rockefeller Center
6. Port Authority Inland Terminal

Wards Island Sewage Treatment Works

The Wards Island Sewage Treatment Works is located on Wards Island in the East River, at Hell Gate, near the junction of the East and Harlem rivers. It is to be an activated sludge plant of 180 mgd capacity, to serve the area in Manhattan and the Bronx tributary to the Harlem River and part of the East River.

The plant is being constructed by the Department of Sanitation and is the first of several plants proposed by the department for the cleaning up of the harbor waters around New York. The works can be reached from the ferry operated by the Manhattan State Hospital at East 116th Street and the Harlem River. Access is through the grounds of the State Hospital (for insane). Passes are necessary and will be secured for those reporting at the ferry house for the 10:00 a.m. boat. To reach the ferry house, take the East Side Subway or the Third Avenue Elevated to 116th Street, or the Second Avenue Elevated to 117th Street.

Eighth Avenue Subway and 207th Street Yard and Shops

Through the courtesy of the Board of Transportation, arrangements have been made for an inspection of the Eighth Avenue or Washington Heights Line, and of the 207th Street Yard and Shops of the Independent Subway System.

The party taking this trip will assemble at the entrance to the 42d Street Station at the northeast corner of 8th Avenue and 42d Street at 10:00 a.m. Guides will be at hand to conduct the party in small groups over the operated subway, the 207th Street Yard and Shops, and return. The trip will occupy about two hours, and will require only the five-cent subway fare for the trip to the yard and also for the return. The stations are more spacious than those of the earlier subways. The flexing of tracks to avoid all grade crossings is also worthy of note. Under Fort Washington Avenue, where the tunnel method of construction was employed, the tracks are 162 ft below the street level.

© Westchester County Park Commission

HUTCHINSON RIVER PARKWAY, WESTCHESTER COUNTY, N.Y.

Construction of the Independent Subway System for the City of New York was started in 1925. The part now under operation includes 12 miles of route and 47 miles of track extending from Fulton Street to 212th Street. The cost was $165,000,000 and operation was begun by the city on September 10, 1932, after efforts to secure a private operator had failed.

Westchester County Parkway Developments

The members visiting the work of the Westchester County Park Commission will take the 9:03 a.m. train from Grand Central Terminal to Bronxville, arriving at 9:33 a.m. Here they will be met by engineers of the commission and go by automobile over the Bronx River Parkway, with a side trip to visit the Kensico Dam and aeration fountains. The group will then go over the Bronx Parkway extension to Croton Lake to see the 750-ft three-hinged arch span over Croton Lake.

Playland Park and the Hutchinson River Parkway Development will be seen on the return, after which the group will come back to New York by train.

Transatlantic Pier Terminal

Through the courtesy of the Department of Docks of the City of New York, and the contractors, Allen N. Spooner and Son, Inc., opportunity will be afforded of visiting the work on the pier terminal under construction on the North River between 48th and 56th streets, to accommodate the latest type of transatlantic liners like the Normandy, which are more than 1,000 ft long.

This work involved the construction of a cofferdam 2,095 ft long, in which 6,900 tons of sheet piling and 180,000 cu yd of fill were used. The piers, three in number and 1,100 ft long, will be the latest type adopted by the Dock Department. The party will congregate at the Field Office of the contractor at 47th Street and North River at 10:00 a.m.

Rockefeller Center

This development, which is located in midtown New York, is the largest single privately financed construction operation ever undertaken. It will cover three city blocks, or an area of about 12 acres. The development includes 11 individual buildings, among which will be the largest skyscraper and the largest theatre ever constructed. The central skyscraper in the group extends 832 ft above the street level. Although it is about 400 ft shorter than the Empire State Building, it exceeds that building both in area of rentable office space and in steel tonnage.

Those visiting this work will assemble at the Field Office on the west side of Fifth Avenue between 49th and 50th streets at 10:00 a.m.

© Westchester County Park Commission

BOARDWALK AT PLAYLAND, RYE BEACH, N.Y.

© Fairchild Aerial Survey, Inc.

TRANSATLANTIC PIER TERMINALS, HUDSON RIVER

Inland Terminal Building, Port of New York Authority

Members visiting the Inland Terminal Building will go to 111 Eighth Avenue, where they will be met and conducted over the building. The Seventh Avenue and Eighth Avenue subways or the Ninth Avenue Elevated to 14th Street may be used conveniently.

The Inland Terminal Building at Eighth and Ninth avenues, 15th to 16th streets, Manhattan, erected by the Port of New York Authority, combines a Union Freight Station for less-than-carload freight, with 14 floors of commercial space available for lofts, light manufacturing show rooms, and offices. In cubic capacity, this is the largest structure on Manhattan Island. Among other innovations, it contains four of the largest high-duty elevators ever built, with platforms 17 by 34 ft.

Reduced Railroad Fares—Hotel Rates—Tickets

REDUCED RAILROAD RATES

Reduced rates on the identification certificate plan have been granted by the passenger associations of the United States and the lines of the Canadian Passenger Association. A certificate authorizing purchase, at starting point of round-trip tickets good for 30 days, on the one and one-half fare basis, has been mailed to the membership of the Society.

Selling dates for tickets in the territory of the Trunk Line, New England, Central, Southeastern, and Canadian (Eastern Lines) Passenger Associations are January 14 to 20.

In the territory of the Southwestern, Western, Trans-continental and Canadian (Western Lines) Passenger Associations, the opening dates of sale vary from January 5 to 14, and the closing dates from January 10 to 20 depending upon location and travel. As certificates cannot be used after the closing date of sale, consult your ticket agent about the selling dates in your territory.

HOTEL RATES

	Without Private Bath		With Private Bath	
	Single Room	Double Room	Single Room	Double Room
Roosevelt	......	......	$4.00 up	$6.00 up
Astor	$2.00 up	$3.00 up	3.00 up	4.00 up
Commodore	......	......	3.50 up	5.00 up
Lexington	......	......	3.00 up	4.00 up
McAlpin	2.50 up	4.00 up	3.00 up	4.50 up
Murray Hill	2.00 up	4.00 up	2.50 up	4.50 up
New Yorker	......	......	3.50 up	5.00 up
Pennsylvania	......	......	4.00 up	6.00 up
Plaza	......	......	5.00 up	8.00 up
Prince George	......	......	2.50 up	3.50 up
Savoy-Plaza	......	......	5.00 up	8.00 up
Taft	2.00 up	3.00 up	2.50 up	3.50 up
Vanderbilt	......	......	3.00 up	6.00 up
Waldorf-Astoria	......	......	6.00 up	9.00 up
Wellington	2.00 up	3.00 up	2.50 up	3.50 up

NOTE: The Hotel Roosevelt, at which the Reception, Dinner, and Dance will be held, will care for reservations to the extent of its capacity.

HOTEL ACCOMMODATIONS

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Annual Meeting, paying for the rooms in advance for at least a part of the period during which they expect to be in New York.

INFORMATION DESK

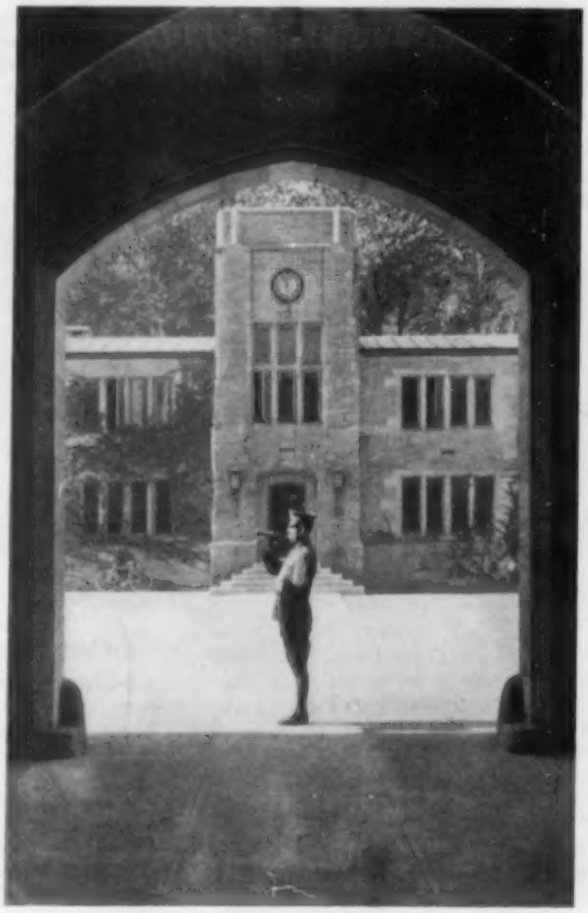
An information desk is provided in the Reading Room of the Society on the Fifteenth Floor of the Engineering Societies Building to assist visiting members in obtaining hotel reservations, theater tickets, and information about the city. Your attention is called to the facilities of the Reading Room (open until 9:00 p.m., Tuesday, Wednesday, and Thursday evenings), for meeting friends, writing letters, and receiving mail. All members are welcome to inspect and utilize the quarters of the Society.

INTRODUCTIONS FOR VISITING MEMBERS

Members who wish introductions or meetings with engineers in New York City during their attendance at the Annual Meeting, may call on the Secretary's office for any service desired.

YOUR NEW YORK ADDRESS

At the Registration Desk, a card file of those in attendance will be maintained, with information as to members' hotel addresses in New York. Members are requested to keep Headquarters informed as far as possible of their New York addresses so as to expedite the delivery of telegrams, telephone messages, and mail.



RECALL AT WEST POINT
United States Military Academy

ORDER ALL TICKETS IN ADVANCE

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at Headquarters, but they will assist the committee greatly in giving advance information to guide it in concluding arrangements. Ticket order blanks have been mailed to each member with the railroad certificate and condensed program.

No cancellation of tickets can be made after noon of Wednesday, January 18, 1933.

COMMITTEE ON LOCAL ARRANGEMENTS FOR THE ANNUAL MEETING

CHARLES E. TROUT,
Chairman

WILLIAM J. SHEA,
Vice-Chairman

EDWARD ANDERBERG
DAVID BONNER
MONTGOMERY B. CASE
WILLIAM MCK. GRIFFIN
ALBERT B. HAGER
WILLIAM L. HANAVAN
PHILIP KEENE
ENOCH R. NEEDLES
EMIL PRAEGER
BILLINGS WILSON

LADIES COMMITTEE

MRS. CHARLES E. TROUT,
Chairman

MRS. WILLIAM MCK. GRIFFIN,
Vice-Chairman

MRS. FREDERICK C. NOBLE,
Vice-Chairman

MRS. WILLIAM J. SHEA,
Vice-Chairman

MRS. O. H. AMMANN
MRS. EDWARD ANDERBERG
MRS. DAVID BONNER
MRS. MONTGOMERY B. CASE
MRS. ALBERT B. HAGER
MRS. WILLIAM L. HANAVAN
MRS. L. G. HOLLERAN
MRS. OTIS E. HOVEY
MRS. CHARLES A. MEAD
MRS. ENOCH R. NEEDLES
MRS. J. P. H. PERRY
MRS. EMIL PRAEGER
MRS. ROBERT RIDGWAY
MRS. GEORGE T. SEABURY
MRS. OLE SINGSTAD
MRS. E. W. STEARNS
MRS. ARTHUR S. TUTTLE
MRS. BILLINGS WILSON

Please call on the Committee on Local Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Prizes Awarded for Outstanding Papers

DAVID L. YARNELL FLOYD A. NAGLER
J. James R. Croes Medal for Paper, "Effect of Turbulence on the Registration of Current Meters"

CLIFFORD ALLEN BETTS
Thomas Fitch Rowland Prize for Paper, "Completion of Moffat Tunnel of Colorado"

EARL A. BROWN
James Laurie Prize for Paper, "The Chesapeake and Delaware Canal"

FRED LAVIS
Arthur M. Wellington Prize for Paper, "Highways as Elements of Transportation"

ARTHUR R. C. MARKL
Collingwood Prize for Juniors for Paper, "The Shannon Power Development in the Irish Free State"

Papers in Transactions Awarded Prizes

EACH year the Society awards a number of prizes in recognition of particularly meritorious papers published in TRANSACTIONS. In a sense, all Society papers are "prize-worthy" in that they are the cream of a much larger group submitted, from which only relatively few are finally given a place in the limited printing program. These prizes, then, are intended as a special encouragement to the preparation of such papers for printing in TRANSACTIONS and to raise their standard of excellence.

All papers printed in TRANSACTIONS during the previous year are considered eligible. For example, those in the present group appeared in the 1931 issue, Vol. 95. They were examined critically by a committee appointed by the Board of Direction for compliance with the Code of Rules. The committee's recommendations were acted upon by the Board at its Atlantic City meeting in October. Public presentation of the prizes will take place at the Annual Meeting. The prize winners are listed in a brief item appearing on page 714 of the November issue of CIVIL ENGINEERING; and photographs of the winners, together with the titles of the papers for which the awards were made, appear in this issue, on the preceding page. Short biographical sketches of the 1932 prize winners follow:

CLIFFORD ALLEN BETTS, M. Am. Soc. C.E., is an expert in the field of hydraulic and concrete research, whose engineering accomplishments include municipal and sanitary work in the East; railroad surveys, mill construction, and a map of the Columbia River in the Northwest; and water investigations and tunneling in Colorado. Following his work on the Moffat Tunnel in Colorado, he has been with the U.S. Bureau of Reclamation since 1928, employed on the construction of the Owyhee Dam in eastern Oregon. A graduate of Yale and of the University of Wisconsin, he was, in 1914, a scholar in hydraulic research work at the Hydraulic Laboratory of the University of Wisconsin.

EARL I. BROWN, M. Am. Soc. C.E., has had an interesting and varied career in the Corps of Engineers of the U.S. Army. He has served both in this country and in our foreign possessions, where he has specialized in such engineering fields as river and harbor improvement; bridge, dam, and road construction; and topographic surveying. During the War, as Division Engineer of the 92d Division, he participated in engagements in the St. Die Sector and in the Argonne offensive. Later he became Chief Engineer of the Fifth Corps of the A.E.F. and finally commanded the 21st Engineers, Light Railways.

FRED LAVIS, M. Am. Soc. C.E., has been a consulting engineer in private practice in New York City since 1909, specializing in transportation, economics, railway location and construction. He is the author of several books and articles on engineering subjects and has been special lecturer at Rensselaer and at Princeton and Yale universities on the economics of railway location and transportation. From 1924 to 1928 he was engaged under the direction of the New Jersey State Highway Commission on the design and construction of Route 1 Extension, and from 1928 to 1931 was President of the International Railways of Central America.

ARTHUR R. C. MARKL, Assoc. M. Am. Soc. C.E., has specialized in water-power and industrial developments. In 1925, he became general assistant and secretary to the chief engineer of the contractor for the Shannon Power Development in the Irish Free State, with a wide range of odd duties. Later he was employed by the Atmospheric Nitrogen Corporation in the design of their new plant at Hopewell, Va., by the Allied Engineers, Inc., in the design of the Oxbow Dam in Michigan, and by Arthur G. McKee and Company of Cleveland, Ohio, in charge of reinforced concrete design for the Magnitostroy steel plant in Russia. At present he is employed by M. W. Kellogg and Company on the design of heavy foundations and pump houses in connection with oil-refinery developments.

FLOYD A. NAGLER, M. Am. Soc. C.E., has twice been awarded the Society's Collingwood Prize for Juniors, and in 1931 won the Norman Medal. He is Professor of Hydraulic Engineering, and Director of the Iowa Institute of Hydraulic Research at the State University of Iowa. As consulting engineer he has served on various hydraulic engineering projects. He is the author of numerous articles on technical subjects.

DAVID L. YARNELL, M. Am. Soc. C.E., is Senior Drainage Engineer in the Bureau of Agricultural Engineering of the U.S. Department of Agriculture at the Iowa Institute of Hydraulic Research. He has conducted specific investigations on all types of trenching and excavating machinery for use in the reclamation of swamps and lands subject to overflow, and he has also made hydraulic researches on the flow of water in drain tile and culverts, through bridge piers, and around bends.

In announcing the award for the Collingwood Prize for Juniors, honorable mention was given the paper, "Plastic Flow in Concrete Arches," by Lorenz G. Straub, Jun. Am. Soc. C.E. Mr. Straub, one of the 1927 Freeman Traveling Scholars, later was associated with the Mississippi River Commission and is now teaching engineering at the University of Minnesota, at Minneapolis.

Engineers' Council for Professional Development Initiates Program

SEVEN national engineering bodies have organized the Engineers' Council for Professional Development, with the announced objective of advancing the professional status of the engineer. The participating bodies and their representatives are:

American Society of Civil Engineers: J. Vipond Davies, Harrison P. Eddy, and C. F. Loweth, all Members Am. Soc. C.E.

American Institute of Mining and Metallurgical Engineers: Donald F. Irvin; D. H. McLaughlin; and Benjamin F. Tillson, M. Am. Soc. C.E.

American Society of Mechanical Engineers: C. F. Hirshfeld; J. H. Lawrence, M. Am. Soc. C.E.; and W. E. Wickenden.

American Institute of Electrical Engineers: Charles F. Scott, C. O. Bickelhaupt, and L. W. W. Morrow.

American Institute of Chemical Engineers: H. C. Parmelee, A. B. Newman, aud John M. Weiss.

Society for the Promotion of Engineering Education: Robert I. Rees; and H. P. Hammond and Dugald C. Jackson, Members Am. Soc. C.E.

National Council of State Boards of Engineering Examiners: D. B. Steinman and T. Keith Legaré, Members Am. Soc. C.E.; and P. H. Daggett.

This new agency plans to coordinate and promote efforts directed toward higher professional standards. Its immediate objective is the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the man himself, by the profession, and by the public through the development of those qualifications that render the engineer a valuable member of society. It is believed that this will promote development along social, economic, and general cultural lines as well as the maintenance of high technical standards of engineering education and practice.

The Engineers' Council for Professional Development is embarking on a program of improving means for the educational guidance of young men with respect to the engineering profession, the formulation of criteria for colleges of engineering, the determination of a program of personal and professional growth for young engineering graduates, and the formulation of methods whereby engineers who have met suitable standards may receive corresponding professional recognition.

Four committees have been appointed to carry on this program They are:

The Committee on Student Selection and Guidance; Harrison P. Eddy, Consulting Engineer, Boston, Mass., Chairman.

The Committee on Engineering Schools; Dr. Karl T. Compton, President, Massachusetts Institute of Technology, Chairman.

The Committee on Professional Training; Robert I. Rees, Assistant Vice-President, American Telephone and Telegraph Company, Chairman.

The Committee on Professional Recognition; Conrad N. Lauer, President, Philadelphia Gas Works, Chairman.

Unemployment Relief Activities for Engineers in New York

A Report of the Year's Efforts of the Members of the Founder Societies in the Metropolitan District

By J. P. H. Perry, M. Am. Soc. C.E.

Formerly Chairman of Executive Committee, Professional Engineers' Committee on Unemployment

THE Professional Engineers' Committee on Unemployment, locally known as the P.E.C.U., has concluded its first year of activity. On October 1, 1932, it appointed a new executive head and a fresh group of officers to manage its affairs, and is now aggressively engaged on its second winter's labor in finding vitally necessary work for the engineers of the district and relieving destitution among them. An account of the organization of the P.E.C.U. appeared in the February 1932 issue of Civil Engineering, *and a progress report up to May 14, 1932, was published in the June issue. Here follows a report of the stewardship of that aggressive group who carried the burden of the first year's relief operations. Not only will this constitute a report to the members of the four Founder Societies who contributed of their time and means to the support of this worthy work, but also it may serve as a guide and stimulus to other similar groups elsewhere.*

In the February and June (1932) issues of Civil Engineering there appeared articles outlining the organization, aims, and activities of the Professional Engineers' Committee on Unemployment up to May 14, 1932. It seems appropriate for those active in the creation and operation of the P.E.C.U. for the first year of its existence to make a report to the members of the four Founder Engineering Societies of the results accomplished.

On October 1, 1932, the Professional Engineers' Committee on Unemployment, covering the Metropolitan District of New York, was reorganized under new leadership with Frederic R. Harris, M. Am. Soc. C.E., as executive head. H. deB. Parsons, M. Am. Soc. C.E. and Mem. A.S.M.E., formerly General Chairman, and J. P. H. Perry, M. Am. Soc. C.E., formerly Chairman of the Executive Committee, resigned because of the pressure of other duties and because it seemed wise to give opportunity to a new group to manage the work of assisting unemployed engineers. This new group is now carrying on aggressively the vitally necessary work that the P.E.C.U. was originally organized to undertake.

What follows immediately is in part a brief recapitulation, as of September 1932, of the figures presented in the June issue of Civil Engineering.

Distribution of Registered Unemployed

In that report, statement was made that up to May 14, 1932, the P.E.C.U. had registered a total of 2,689 unemployed engineers. Since that date a careful re-check has been made of all registrations and a reclassification has been effected. As a result of this restudy during the less active summer months, we find that in our early registrations certain duplications had crept in so that the correct figures, eliminating all duplications, show a total registration from November 1, 1931, to October 1, 1932, of 2,188 men. Of these active registrants, the committee made 1,514 placements, divided as follows:

On the P.E.C.U. payrolls	308
Receiving other relief such as that given by the Gibson, Bliss, and other general public committees in the Metropolitan District of New York	960
In permanent jobs (engineering and otherwise)	246
Total	1,514

The 1,514 placements include 182 men who were placed more than once, or a net total of 1,332 individuals placed in jobs. Thus 61 per cent of all engineers who have registered with the P.E.C.U. have been supplied with jobs.

The division among Society members and non-members, both as to registration and placement, is shown in Table I.

The analyses of registration and placements by married and single classifications and also by grouping of salaries received by the registered man in his last employment, are shown in Table II.

The occupations of these twelve hundred odd men for whom we found places in other organizations do not vary materially in summary from the outlines given in the report published in the June issue of Civil Engineering. To attempt to detail the very

Table I. Division Among Society Members and Non-Members

Society	Registered	Per Cent of Total Registration	Placed	Per Cent of Total Placed	Per Cent of Registered Placed
American Society of Civil Engineers	240	10.9	204	15.2	85.0
American Institute of Metallurgical and Mining Engineers	35	1.5	33	2.5	94.3
American Society of Mechanical Engineers	357	16.2	277	20.7	77.5
American Institute of Electrical Engineers	212	9.6	173	12.9	81.6
Western Society of Engineers	4	0.3	4	0.3	100.0
Non-members	1,349	61.5	648	48.4	48.3
	2,197	100.0	1,339	100.0	
Duplicate memberships	9		7		
	2,188		1,332		
Men placed more than once			182		
Total			1,514		

many varieties of work which our registered unemployed engineers engaged in would make this report far too lengthy.

Source of Funds

The registering and placing of these men were made possible through the Finance Committee under the splendid leadership of H. A. Kidder, Fel. A.I.E.E. This committee raised in cash $118,641.49 and in pledges (not paid by September 30, 1932), $3,198.25. In addition, the Relief Committee obtained donations of clothing of a conservative second-hand value of $5,695.30. Thus a grand total of "relief" was obtained directly by the P.E.C.U. of $127,535.04. Of this money, $5,788.50 was allocated for disbursement outside the Metropolitan District of New York. Of the grand total of money raised, there was specifically contributed (principally by the metropolitan sections of the four Founder Societies and by William Heyman, M. Am. Soc. C.E., who gave $1,000) for "administration" the sum of $6,247.59.

Table II. Classification of Registrants

Marital Status	Registrations		Placements
Single	655		265
Married	1,449		1,039
Widowed	33		18
Divorced	29		10
	2,166		1,332
Unaccounted for	22	Replacements	182
Totals	2,188		1,514

Salary	Registered		Placed
$6,000 or better	130		106
$3,600–$6,000	512		381
$2,400–$3,600	1,028		627
$2,400 and below	496		218
	2,166		1,332
Unaccounted for	22	Replacements	182
Totals	2,188		1,514

This left a total raised by general canvassing in the Metropolitan District of New York of $109,803.60, which sum came from 3,503

individuals. The number of contributors and the amount individually contributed by the members of the four Founder Societies may be classified as follows:

	Number of Contributors	Per Cent of Total	Per Cent of Membership in P.E.C.U. Territory	Total Contributions	Per Cent of Total Contributions	Average
Civil	787	22.46	22.5	$34,577.38	31.4	$43.90
Electrical	1,134	32.40	30.4	22,522.62	20.5	19.84
Mechanical	1,115	31.83	38.3	25,312.60	23.0	22.67
Mining	265	7.56	8.8	12,222.47	11.2	46.12
Non-members	202	5.75	....	15,168.53	13.9	75.09
	3,503	100.00	100.0	$109,803.60	100.0	$31.32

In addition to raising the foregoing funds, the P.E.C.U. found temporary work for its registered unemployed engineers with "other relief organizations." The wages paid by these other organizations to our registered men from November 1, 1931, to September 30, 1932, totaled $641,314.00. These wages paid "by others" are classified as follows:

Gibson Committee, Emergency Work Bureau	$231,464.00
Bliss Committee, C.C.W.B.	291,500.00
Temple Act (U.S. Geological Survey)	15,136.00
Westchester County Park Commission	58,549.00
Nassau County Relief Commission	33,823.00
Bergen County Relief Commission	5,905.00
Other New Jersey Relief	2,505.00
Yonkers Emergency Work Burden	1,412.00
Department Stores, New York City	1,020.00
Total temporary "other relief"	$641,314.00

Together with the relief afforded directly from the P.E.C.U.'s funds and the "other relief" obtained from the public relief organizations, as set forth in the preceding paragraph, the P.E.C.U.'s registered men placed on permanent jobs (engineering and otherwise) received wages to an amount of $139,914. This figure is approximate but is based on a series of post card surveys and individual checks and is believed to be reasonably accurate.

It thus appears that the total "relief" made available for registered unemployed engineers by the P.E.C.U. for the period covered by this report was as follows:

Cash for relief funds	$112,393.90	
Cash for administrative purposes	6,247.59	
Second-hand clothing of value	5,695.30	
Unpaid pledges on September 30, 1932, still regarded as collectable and good	3,198.25	
Total raised directly by the P.E.C.U.		$127,535.04
Value of wages paid to the P.E.C.U.'s registered engineers by "other relief organizations"		641,314.00
Wages earned by the P.E.C.U.'s registered engineers on permanent jobs (engineering and otherwise)		139,914.00
Total "relief" made available through the P.E.C.U.		$908,763.04

In the period covered by this report, the P.E.C.U. made disbursements from the funds at its command as follows:

Salaries to registered unemployed engineers	$81,017.72
Loans and emergency loans	6,808.40
Clothing (conservative second-hand value)	5,332.25
Total	$93,158.37

This means that the P.E.C.U. actually afforded "relief" to unemployed engineers through its own funds and through wages paid by others ($781,228.00) to a total of $874,386.37. In addition, the administrative expenses of the P.E.C.U. were $5,945.98, or a total for relief and disbursements for the period of $880,332.35.

On the basis of the total relief afforded to unemployed engineers by the P.E.C.U., the administrative expense was two-thirds of 1 per cent. The administrative expenses represented printing, postage, telephone, traveling expenses, etc. The P.E.C.U.'s overhead expense would include this item of administrative expense and in addition presumably the payroll for the headquarters staff, which at one time ran as high as 60 men. All this payroll of headquarters administration went to unemployed needy engineers and was one form of our made work. A few of the headquarters staff also were volunteer workers.

The actual relief afforded to unemployed engineers, which amounted to $874,386.37, was distributed to 1,332 individuals, an average per man of $656.45, or of approximately $60 per man per month. This latter figure is misleading, as the period of employment of 1,332 men varied widely from a day or two to a matter of months.

The relief afforded the individual unemployed engineer through the P.E.C.U. has varied somewhat depending on where it was obtained. The average, as closely as we can calculate, under different conditions was as follows:

For those paid direct through the P.E.C.U.	$22.55 per week
For those who obtained relief through the Gibson, Bliss, and other public relief committees	$13.67 per week
For those who got permanent jobs, engineering or otherwise, through the P.E.C.U.	$28.00 per week

On October 1, 1932, the outgoing P.E.C.U. administration turned over to the new officers (Admiral Harris and his associates) funds as follows:

Cash	$24,869.39
1931–1932 pledges receivable as of September 30, 1932 (still regarded as good)	3,198.25
Second-hand clothing valued at	363.05
Total immediate assets	$28,430.69
Additional contingent assets of notes receivable for loans made to unemployed engineers	6,808.40
Total assets	$35,239.09

When President Hoover and the Engineers' Club of New York City donated $7,500 to the P.E.C.U. with the provision that this money was to be nationally distributed, the P.E.C.U., as previously reported, kept for its own use that proportion of this money which the membership of the four Founder Societies resident in the Metropolitan section of New York bore to the national membership. This was a fraction over 22 per cent. The remaining $5,683.35 was turned over to the National Engineers' Relief Committee, composed of four representatives of each of the Founder Societies nominated by the secretaries of the Founder Societies at the request of the P.E.C.U. The chairman of this special subcommittee of the P.E.C.U. was Ely C. Hutchinson, Mem. A.S.M.E. The Woman's Engineering Club of New York City and one individual later contributed $105.20 to this subcommittee. As of September 30, 1932, this National Engineers' Relief Committee had left undistributed $4,258.55. The remainder had been loaned to needy engineers resident outside the Metropolitan District.

As stated in previous reports, the loans we made were of two classes—in petty amounts for immediate emergencies, such as lending a man carfare to get a job or lending him enough to feed himself for a day or two, and the like. The great majority of our loans were of a more formal nature, running from $25 to $100, where the borrower gave an unsecured demand note without interest. Up to September 30, 1932, a total of $225 had already been received in partial repayment of six of these loans.

As stated in the June report, "The relatively small number of loans made and the meager sums of money required surprised those active in the P.E.C.U..... Apparently engineers (especially our members) are extremely loath to apply for loans."

As of May 15, 1932, all made work paid for directly by the P.E.C.U. was stopped. The only payroll of the P.E.C.U. after that date was for about 20 of the permanent organization engaged in administering the activities of the P.E.C.U. for the remainder of the year, in statistical work, and in getting ready for the opening of the 1932 fall campaign. It was estimated that when made work was stopped, there were about 50 destitute engineers—classified as "A A" and members of the Founder Societies—who were in such dire circumstances that they would have to be carried for the remaining five months on a loan basis. It was estimated we would have to loan $17,000 or $18,000 during this period. As a matter of fact, from May 15 to October 1 we loaned only $2,089.00. This is direct confirmation of the statements just quoted.

Undoubtedly this situation will be considered by the new P.E.C.U. administration and may lead them to curtail materially on made work and extend our loan funds. The facts seem to be that an enemployed engineer who gets a made-work job is prone to get into a rut. His morale is frequently so broken down that he does not dare to take time off from his made-work job to look for a permanent job, or he has lost heart and does not even attempt

to find other work. When his made-work job is stopped, however, it seems to act as a new stimulus to make him find some means of support for himself or to force him to go back to the "home folks" or to "the country." At any rate, it seems to be clear that engineers hate to borrow and incur the moral obligation of repaying their loans.

The collection of clothing continued from the time of my last report (as of May 14) to September 30. A total of 1,650 pieces of clothing, including every variety of wearing apparel, but mostly men's suits and overcoats, was collected. This was distributed to 470 people, mostly men, though we were able to outfit some women and a good many children.

Those active in the management of the P.E.C.U. for the past year were fortunate in being able to arrange with Harold B. Atkins, Mem. A.S.M.E., certified public accountant, for an audit of its books. Mr. Atkins offered to make this audit gratuitously as his contribution to the work of the P.E.C.U. in relieving destitute engineers. He did a most thorough, painstaking, and lengthy job and has submitted a complete report, which is the basis for the figures used in this article. The thanks of all those active in the P.E.C.U. are extended to Mr. Atkins.

There was no exact way in which Mr. Atkins could certify to the figure of $781,228.00 given as the value of wages paid "by others" to unemployed engineers certified to these "other organizations" by the P.E.C.U. This figure for the value of wages paid was very carefully made by the P.E.C.U. headquarters organization and checked in several ways. It is believed to be closely correct. Records were kept of each man employed by "other organizations" and postal card and other checks were made to determine the length of time each man was so employed. We then obtained from those organizations the weekly wage rate applying to each class of occupation. There may be some errors, but they are probably compensating. The figures are believed to be on the conservative side.

In conclusion, I would like to repeat and emphasize as vigorously as I know how, the statements made in two previous reports, that while it may fairly be said that the P.E.C.U. did well to raise $118,641.49 in cash and nearly $10,000 more in "as yet unpaid pledges" and in "contributed clothing," its real accomplishment was its success in placing approximately 1,200 unemployed engineers on someone's else payroll, so that from this source they received in wages $781,228.00. Out of a total "relief" (including clothing) given in 11 months by the P.E.C.U. to unemployed engineers of $874,386.37, almost 90 per cent was obtained through having our men paid by others.

By careful organization, concentration, and aggressiveness, the P.E.C.U. was able to show the great public relief organizations in the New York Metropolitan District the merit of their using unemployed professional engineers for key and supervisory positions in organizing and directing the made-work activities of thousands of men paid for by the millions of dollars contributed from public funds and private charity. A similar great opportunity probably awaits the P.E.C.U. during its second year.

If the engineering profession were to rely only on the money it could raise from its own members to take care of the unemployed engineers, the result would be unsatisfactory, but if it continues to persuade other relief organizations to use engineers, as was done the first year of the P.E.C.U.'s activity, the relief that the committee can afford to suffering engineers may be greatly enhanced.

Our chairman, H. de B. Parsons, and I do not want to submit this report without expressing our very warmest gratitude to our fellow members of the General Committee, and particularly to the members of the Executive Committee and to the following gentlemen who were chairmen of our more important standing committees:

JOHN P. HOGAN, M. Am. Soc. C.E., Mem. A.S.M.E., and Mem. A.I.E.E., Chairman of the Legislative Committee.

H. A. KIDDER, Fel. A.I.E.E., Chairman of the Finance Committee.

ALFRED D. FLINN, M. Am. Soc. C.E., and Mem. A.I.M.E., Chairman of the Clearance Committee.

GEORGE L. LUCAS, M. Am. Soc. C.E., Chairman of the Relief Committee, and to his successor for a brief period, J. S. LANGTHORN, M. Am. Soc. C.E.

WILLIAM HEYMAN, M. Am. Soc. C.E., Chairman of the Administration of Funds Subcommittee.

ERNEST S. HOLCOMBE, Fel. A.I.E.E., Chairman of the Registration Committee.

RALPH T. ROSSI, Assoc. A.I.E.E., Chairman of the Industrial Opportunities Committee.

JAMES M. WEBSTER, M. Am. Soc. C.E., and ALFRED H. MEYER, Assoc. Mem. A.S.M.E., the two secretaries of the Executive Committee.

All these men and the entire personnel of our organization gave unstintingly of their service to bring about whatever the P.E.C.U. may be considered to have accomplished.

If there is any broad credit coming to the P.E.C.U. for its first year's work, a large part of it should go to George L. Lucas, who, as president of the Metropolitan Section of the Society, in the summer of 1931 foresaw the problem and had the initiative and the energy to bring about the organization of the P.E.C.U. Mr. Lucas was largely responsible for securing the personnel and was directly responsible for the splendid work the Relief Committee did in finding made work.

Exempt from Dues

ACCORDING to the Constitution, a member of the Society who has paid dues for 35 years or, having reached the age of 70 years, has paid dues for 25 years, is exempted from such annual payments. In the 1932 Year Book of the Society, pages 115–118, is to be found a list of the members—already nearly 525 in number—who, in January 1932, were exempt from the payment of further dues. To this list are now to be added the names of 80 additional members who have consistently and continuously kept up their interest in, and affiliation with, the Society for a period of 25 or 35 years. The additions that should be made to the list published in the Year Book to make it complete, as of January 1, 1933, are as follows:

Alden, Charles Ames
Allen, Frank William
Baird, Howard Carter
Baldwin, Ernest Howard
Barnes, William Thomas
Bausher, Carmi Irving
Briggs, Benjamin E.
Brunner, John
Burdett, Frederick Anderson
Byers, Morton Lewis
Carter, William J.
Child, Stephen
Clark, George Hallett
Corry, Thomas Avery
Crane, Albert Sears
Curtis, Charles Elbert
Davis, Carleton Emerson
Dawson, Edwin Ford
Dean, Luther
Dow, Alex
Easby, William, Jr.
Ferris, Frederick Edward
Foss, Fred Eugene
Frink, Ellis Alexander
Garrett, James Edwin
Harley, Alfred Francis
Harman, Jacob Anthony
Harris, Van Alen
Hartranft, William Garrigues
Hartwell, Harry
Hayes, Henry Wild
Hazard, Schuyler
Hegardt, Gustave Bernard
Hogue, Charles Jay
Holbrook, Percy
Hook, Gulian Schmalz
Howard, John Lewis
Hoyt, John T. Noye
Irwin, James Clark
Jackson, Dugald Caleb
Johnson, Lucien Samuel
Jones, Henry Llewellyn
Leffingwell, Frank Dodge
Low, George Evarts
MacGregor, Robert Athole
McCulloch, Richard
McGilvray, Thomas Forrester
McInnes, Frank Alexander
McNaugher, David White
Miner, Edward Fuller
Moir, Ernest William
Monks, John
Moses, John Cranch
Myers, Edmund T. D., Jr.
Myers, John Hays
Ogawa, Umesaburo
Ogden, Henry Neely
Palmer, Frederick
Paquette, Charles Alfred
Phillips, Asa Emory
Quick, Alfred Merritt
Reichmann, Albert Ferdinand
Ridgway, Robert
Rosecrans, William Henry
Rust, Henry Bedinger
Schultze, Paul
Sirrine, Joseph Emory
Smoot, Edgar Kenneth
Stewart, Clinton Brown
Strahan, Charles Morton
Strong, William Edward Schenck
Tainter, Frank Stone
Thian, Prosper Eugene
Tighe, James Lawrence
Touceda, Enrique Augusto
Turner, Daniel Lawrence
Ulrich, John Clarence
Walker, Elton David
Warrington, Harry Esmond
Wilkerson, Thomas Jefferson

It is inspiring to read this long list of men, many of whom became members prior to 1900, when the total membership of the Society had barely passed the two thousand mark, and to realize that so large a group of engineers have found continued interest and profit in the work of the Society.

A Preview of Proceedings

Three main papers and a special committee report, together with discussions of current papers, will make up the January issue of PROCEEDINGS. *Of the papers, the first deals with a simplified method of analyzing wind stresses in the structural bents of tall buildings. The remaining two papers are the first in* PROCEEDINGS *to deal with the construction of the George Washington Bridge across the Hudson River at New York. They constitute the fifth and the sixth papers in the series recording the technical facts concerning this great suspension span. Also in the January issue will be found the first progress report of the active committee appointed about 18 months ago to study means of making the U.S. Weather Bureau more useful to engineers.*

Wind Stress Analysis Simplified

IN MAY 1930 a paper was published in PROCEEDINGS entitled "Analysis of Continuous Strains by Distributing Fixed End Moments," by Hardy Cross, M. Am. Soc. C.E. Although it occupied but ten pages of PROCEEDINGS, it elicited 146 pages of discussion, an indication of the intense interest in the method proposed. This new method of structural analysis seemed to suggest an infinite number of applications and therefore discussion was directed largely toward indicating various ways in which it could be applied.

One of the discussers, L. E. Grinter, Assoc. M. Am. Soc. C.E., introduced a modification of the Cross method, which he referred to as the method of successive corrections. He has now written a paper, to appear in the January issue, in which this general method of successive corrections is used as a background for the presentation of a simplified method for analyzing wind stresses in tall buildings. He applies his theory to the Wilson and Maney bent and the American Insurance Union Building, both of which have been used as examples by writers on this subject. By comparing his results and those of previous writers using a more exact method, Professor Grinter is enabled to discuss the relative errors of his method and their importance in problems of design.

He states that all single-story bents, for example, may be analyzed by the simplified method of successive correction without the introduction of any error from neglected joint restraint. First an analysis is made for the effect of the vertical load. The moments are computed by balancing fixed end moments while the bent is restrained against side sway. When the balanced moments are investigated, there is found to be an artificial joint force acting horizontally at the top of the bent. This is determined numerically by adding the horizontal shear in all the columns and by adding the horizontal component of the direct stresses in the battered columns. This joint force must next be balanced by an equal and opposite force that may be added algebraically to any real lateral force acting at the top of the bent. Finally, the moments caused by this combined lateral force must be computed, since they must be added algebraically to the first balanced set to obtain the final moment.

An irregular frame is analyzed according to this system by introducing correction moments in one or more stories of the frame. The committee of the Structural Division, on Wind Bracing in Steel Buildings, is particularly active at this time in searching for methods of applying the Cross method to wind bracing. The present paper is an interesting and valuable contribution in this connection.

George Washington Bridge: Construction of Substructure

THE FOUR PAPERS published to date on the George Washington Bridge—in PROCEEDINGS for August, October, and December—have emphasized the most important new experiences encountered in the design of the bridge. The succeeding four papers will emphasize mostly the technical experiences involved in the construction.

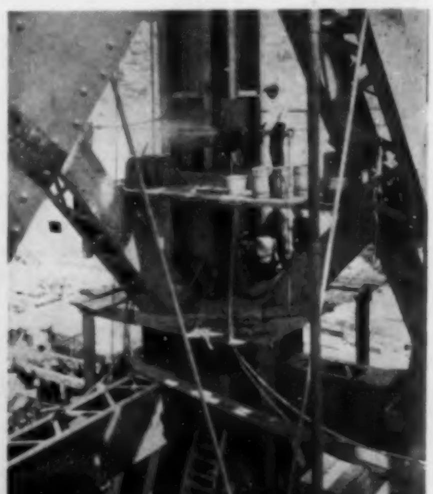
The one by Montogomery B. Case, M. Am. Soc. C.E., the fifth in the series, describes the borings and the conclusions derived from them, the sinking of the caissons, the methods of designing the caissons and the timber bracings, and the manner of excavating. A particularly interesting part of this paper is his description of the steps followed in sinking the shaft and excavating the tunnels for the New Jersey anchorage. Infinite pains were taken to prevent ground water from reaching the anchorage steel. The accompanying illustration is a construction view at one of the anchorage tunnels.

Anchorage girders and eye-bars were located and aligned by means of a steel falsework frame embedded with the anchorage steel. This falsework was fabricated accurately and checked so that instrument work to locate a few of the main members was all that was necessary to fix the exact position of the anchorage steel.

Another important part of Mr. Case's paper is the treatment of the contractor's plant, particularly in relation to the transportation, mixing, and placing of cement and concrete. At the New York anchorage, the contractor produced as much as 1,200 cu yd in a single 16-hr day. The entire mass, approximating 110,000 cu yd, was put in place in $5^1/_2$ months, which was somewhat more than two months ahead of schedule. Mr. Case states that the results obtained on the various contracts for the George Washington Bridge demonstrate fully the economies that are possible by using this method of proportioning concrete.


Approach Cut and Anchorage Tunnels


Walking Cables, Later Used as Hangers


Riveters at Work on Tower Column

CONSTRUCTION VIEWS, THE GEORGE WASHINGTON BRIDGE

George Washington Bridge—Construction of Steel Superstructure

Continuing the series of papers on the design and construction of the George Washington Bridge, E. W. Bowden and H. R. Seely, Associate Members Am. Soc. C.E., as co-authors, are presenting a paper on the construction of the towers, cables, and suspended structure. The paper points out the orderly procedure followed in the construction operations, according to a carefully prepared program. The methods of erection of the towers are described, from the setting of the pedestals on a uniform bearing by an unusual system of mortar bedding, to the erection of the massive cable saddle castings on the tops of the towers. A positive system of signal control permitted accurate placing of column sections weighing over 75 tons. Discontinuance of erection operations when within two panel lengths of the top permitted careful field observations and special milling of the upper sections to ensure uniform bearing at the grillages. About 40,200 tons of structural steel were required to build the towers.

The contract for the cable and anchorage steelwork involved the furnishing and erection of approximately 28,300 tons of cable wire, 170,200 lin ft of steel wire suspender rope $2^7/_8$ in. in diameter, and about 6,000 tons of structural steel and castings.

The four cables were constructed simultaneously in record time considering the quantities involved, the speed in the operation being made possible by improvements in method that are fully described in the paper. Among the special features mentioned are the means of tramway rope support, which permitted high speeds in the wire spinning; special machines for driving the reels; and unusual design of the strand legs and balance beams for placing the completed strands in the cables.

Over 19,000 tons of floor steel were erected in a period of ten weeks with a single pass of the travelers working out from each tower. Main-span steelwork was hoisted directly from car floats anchored in the river, whereas the side-span steelwork was hoisted at the towers and trucked out to the point of erection. Floor beams weighing over 60 tons were the first members erected in each panel.

Meteorological Data

"How can the United States Weather Bureau be of greater service to engineers?" was the question asked of a research committee of the Society authorized on January 19, 1931, and appointed in April 1931. In the 30-page progress report of the Committee on Meteorological Data, to appear in January issue of Proceedings, a brief statement of the background of the study is followed by the committee's recommendations for improving both the quality and scope of the technical material made available by the bureau. The factual findings which form the basis for the recommendations made are included in the report, together with an extended discussion of them.

Answers to questionnaires sent to over two hundred members and others indicated that engineers generally make wide use of the work and publications of the Weather Bureau. The replies contained both favorable comment and criticisms on certain parts of the bureau's work. In general, the dissatisfaction expressed was in regard to the location of the stations at which observations are taken, the quality of the records, and the manner in which the data are published. The committee believes that much of the trouble can be eliminated by a complete reorganization of the bureau without materially increasing the cost of the work now being done by it.

A specific recommendation of the committee is for the initiation within the bureau of specific programs of research, in the carrying out of which the bureau would cooperate with other scientific institutions throughout the country. The report is the result of 18 months of intensive effort on the part of the committee, which consists of Donald M. Baker, Chairman; and Raymond A. Hill, Charles A. Lee, J. B. Lippincott, and the late F. H. Newell, all Members Am. Soc. C.E., assisted by numerous members to whom questionnaires were sent and by a group of Juniors of the Society who made special studies in connection with the report.

News of Local Sections

Arizona Section

This Section held a meeting in Phoenix on November 26. The annual election of officers, which was held at the business meeting in the morning, resulted as follows: R. A. Hoffman, President; D. H. Barber and G. L. McLane, Vice-Presidents; and Clyde Myers, Secretary-Treasurer. Before the adjournment of the morning session, a paper on "Construction Features of the Hoover Dam" was read by Joseph A. Fraps, engineer for the Arizona Certification Board.

The luncheon meeting which followed was well attended, and those present heard talks by G. M. Butler and V. Housholder. In the afternoon, H. Langley, Assistant Landscape Architect of the National Park Service, San Francisco, presented a paper on the "National Park Highways," and C. E. Griggs, City Engineer of Phoenix, read a paper on the "Phoenix, Ariz., Water Sewerage and Sewage Disposal Plant."

Central Ohio Section

The election of officers for this Section for 1933 was held on November 17, and resulted as follows: F. D. Stewart, President; R. R. Litehiser, First Vice-President; Robert T. Regester, Second Vice-President; and W. H. Critser, Secretary-Treasurer.

Cleveland Section

A luncheon meeting was held by the Cleveland Section on Tuesday, November 15. Following the business routine, a very interesting illustrated talk on "The Development of the Forest in Northern Ohio" was given by Arthur R. Williams, of the Cleveland Museum of Natural History.

At a meeting of the Cleveland Section, held on December 6, the following officers for 1933 were elected: R. F. MacDowell, President; William L. Havens, Vice-President; and L. K. Whitcomb, Jr., Secretary-Treasurer.

Dayton Section

The Dayton Section held its regular meeting on October 17 at the Engineers' Club. The speaker for the occasion was George Siebenthaler, landscape architect, who gave a very interesting talk, illustrated with lantern slides of pictures taken during a recent trip through Europe, on landscaping and architectural features. The attendance numbered 18.

Detroit Section

A report from the Detroit Section indicates that its dinner meeting, held on October 18, was enthusiastically attended. A short and excellent address was given by Professor Riggs; and Herbert S. Crocker, President of the Society and guest of honor, gave a very interesting and enjoyable talk, explaining the workings and problems of the Society and relating some of his early engineering experiences. The election of officers for 1933 resulted as follows: Perry A. Fellows, President; Harry A. Shuptrine, Senior Vice-President; Prof. R. H. Sherlock, Junior Vice-President; and W. C. Hirn, Secretary-Treasurer.

Georgia Section

The regular September meeting of the Georgia Section met at the Atlanta Athletic Club on September 12. Transportation problems of the day were discussed by C. C. Boleneau, of the Atlanta and West Point Railroad, who told of the present situation of competition between the railroads and other carriers, the restrictions on the railroads, and the expediency of a ton-mile tax on buses. Interesting comments on this subject were contributed by F. H. McDonald, who presented other features of the problem. There were 23 members and guests in attendance.

Iowa Section

On November 17, the fourteenth annual meeting of the Iowa Section was held in Des Moines. An impressive address was given by E. B. Black, Director of the Society, and a consulting engineer of Kansas City, Mo. A motion picture of "The Effect of the Shape of a Bridge Pier Upon the Scour at Its Base," was

shown by D. L. Yarnell, Senior Drainage Engineer, U.S. Department of Agriculture; and O. W. Crowley, executive secretary and engineer of the Central Branch of the Associated General Contractors of America, spoke on the "National Committees on Public Works and Trade Recovery." The following officers were elected for the coming year: C. H. Currie, President; J. R. Maher Vice-President; R. A. Caughey, Director; and R. B. Kittredge, Secretary-Treasurer.

ITHACA SECTION

A dinner meeting of the Ithaca Section was held at Willard Straight Hall, on the Cornell University campus, on Monday, November 7, with 27 members and guests in attendance. The speaker of the evening was M. A. Timlin, of Philadelphia, whose subject was "Some Faults in Technically Controlled Concrete Specifications."

LOS ANGELES SECTION

The annual meeting and installation of officers of the Los Angeles Section, held December 14 at the Engineers' Club, was attended by 175 members and guests. The program included an account of the progress on the Boulder Canyon Dam Project, given by Walker R. Young, Construction Engineer for the U.S. Bureau of Reclamation at Hoover Dam; and a brief discussion of the policies of the California State Board for Registration of Civil Engineers, by H. J. Brunnier, president of the registration board. Mr. Young made excellent use of slides in presenting a very clear picture of the nature and magnitude of the construction activities at Boulder City and Hoover Dam during the past year. And Mr. Brunnier, in his talk, called attention to those activities of the board which protect the public against unqualified civil engineers and raise the standards of the profession.

Officers for 1933 were installed. The list follows: Ormond A. Stone, President; Gerald Fitzgerald and Alfred Jone, Vice-Presidents; Andrew L. Gram, Secretary; and Kenneth Q. Volk, Treasurer.

MARYLAND SECTION

A joint meeting of the District of Columbia and the Maryland Sections was held at the Engineers Club in Baltimore on Thursday, October 27. There were 31 members of the District of Columbia Section in attendance as the dinner guests of the Maryland Section. The speaker of the evening was Edwin Warley James, Chief of the Division of Design of the U.S. Bureau of Public Roads, who gave an interesting illustrated lecture on "An Engineer's Trip Across Colombia." Mr. James was formerly highway expert on the Colombia National Board of Communications and spoke out of an intimate personal knowledge of the difficult conditions that confront the people of Colombia in their effort to secure satisfactory communication between the sea coast and the interior.

On the evening of November 22, a meeting of the Maryland Section was addressed by Col. E. J. Dent, of the U.S. Army Engineers, on the subject of "Beach Erosion." This lecture was illustrated by many interesting slides, showing the effect of erosion along the Atlantic seaboard. After the meeting light refreshments were served, and the members enjoyed a social hour.

At the annual meeting of the Section, held at the Engineers Club in Baltimore on December 8, officers for 1933 were elected as follows: G. J. Requardt, President; J. T. Thompson, Vice-President; and J. W. Armstrong, Secretary-Treasurer. These officers, with W. T. Ballard and S. L. Thomsen, former presidents of the Section, comprise its board of direction for 1933. After the business meeting, the Maryland Section was the guest of the Johns Hopkins University Student Chapter, which had provided as speaker for the evening, Frank P. McKibben, consulting engineer, who spoke on an interesting bridge spanning the Genesee River at Rochester, N.Y.

METROPOLITAN SECTION

An engineering and geological review of Hoover Dam interested a large group of members and guests at the meeting of the Metropolitan Section, held in New York City on December 21. Robert Ridgway, Past-President of the Society, explained in detail the history and engineering plans adopted for this huge structure, after which Charles P. Berkey, Professor of Geology at Columbia University, covered interesting phases of the geological features of the surrounding country as well as of the dam site itself. Both Mr. Ridgway and Professor Berkey were members of the Engineering Board of Review which passed upon the basic plans for the dam.

Following these illustrated talks, Thaddeus Merriman, consultant on the Metropolitan Aqueduct of Los Angeles, spoke on some of the significant features of the work, including toughness of the rock, regimen of the river, and the silt problem. At the close of the meeting, refreshments were served. The attendance, which was unusually large, numbered about 550. Preceding the technical session, an appeal was made on behalf of the Professional Engineers Committee on Unemployment for clothing for adults and children.

MILWAUKEE SECTION

A joint meeting of the Marquette Student Chapter and the Milwaukee Section was held at the La Salle Hotel, on November 17. The speaker of the evening was Prof. Leslie Van Hagan, member of the Board of Examiners for Architects and Civil Engineers, whose subject was "A Year of Engineering Registration in Wisconsin." The attendance was 76.

NEBRASKA SECTION

The following officers have been elected for the Nebraska Section for 1933: J. G. Mason, President; R. N. Towl, Vice-President; and R. E. Edgecomb, Secretary-Treasurer.

NEW MEXICO SECTION

A dinner honoring Herbert S. Crocker, President of the Society; D. C. Henny, Vice-President; and L. N. Reeve, of Boston, was given by this Section in Albuquerque on Thursday, November 17. There were 40 members and guests in attendance. President Crocker spoke on the aims of the national organization and told of its cooperation with the Reconstruction Finance Corporation in engineering matters. Mr. Henny in his address advocated the six-hour day, and Mr. Reeve spoke on the subject of engineering in Japan.

NORTHWESTERN SECTION

At a meeting held by the Northwestern Section on November 4, the following officers were elected for the year 1932–1933: M. W. Hewett, President; Walter H. Wheeler, First Vice-President; Hibbert M. Hill, Second Vice-President; and Lorenz G. Straub, Secretary-Treasurer. An address was given by Walter H. Wheeler, advisory engineer to the Ninth Reserve District Committee of the Reconstruction Finance Corporation, who discussed the present and probable future activities of the committee in this district.

PANAMA SECTION

On October 4, the Panama Section held a smoker at the Miramar Club, Panama City, in honor of the visiting board of consulting engineers for the Madden Dam: Dr. Elwood Mead, S. O. Harper, J. L. Savage, and L. N. McClellan. Dr. Mead was the principal speaker of the evening, and remarks were made by each of his associates. Moving pictures of models of the spillways for the Hoover and Madden dams were shown. There were 54 engineers present.

PHILADELPHIA SECTION

This Section held its first meeting of the season on November 17. The attendance was very large, 74 members and guests being present at dinner and 145 at the meeting. Jacob L. Warner, manager of the Real Estate Division of E. I. du Pont de Nemours and Company, was the first speaker of the evening. His subject was "The Economic and Engineering Features of Industrial Plant Location and Layout." An address was then given by William O. Munroe, Works Manager, The Baldwin Locomotive Works, on "The Layout of the Eddystone Plant"; and this was followed by an interesting talk on "The Trona Plant of the American Potash and Chemical Corporation," given by B. S. Thayer, Construction Manager, United Engineers and Constructors, Inc. These addresses were generously illustrated with lantern slides.

SACRAMENTO SECTION

At weekly meetings held by this Section, many interesting and instructive subjects have been discussed. On August 23, Charles

P. Craig, Executive Director of the Great Lakes—St. Lawrence Tidewater Association, gave an address on the "Proposed St. Lawrence—Great Lakes Improvement." Annual Ladies Day was observed on October 4, with an attendance of 87. At this meeting F. A. Kittredge, Chief Engineer of the National Park Service, spoke on "Our National Parks"; and at the October 25 meeting, H. L. Wood, of the General Electric Company read a paper entitled "The History and Development of Refrigeration."

Seattle Section

At the regular monthly meeting of the Seattle Section, held on October 31, W. P. Greenawalt spoke on the "Erection of Multi-plate Culvert Pipe"; and Dean Tyler, of the University of Washington, spoke on "Rainfall and Run-off in the Pacific Northwest." Both addresses were illustrated by lantern slides, and the enthusiastic discussion which followed indicated that the subjects were of great interest to those present.

The regular monthly meeting of the Seattle Section was held on November 21 at the Engineers' Club. After dinner and the routine business session, J. L. Lytel gave an illustrated account of his work in connection with building a subway in Buenos Aires. Then Mr. Carlson, from the University of Washington, demonstrated the apparatus used in connection with soil tests made at the university.

Spokane Section

An address by Philip Grant Holgren was the principal event of a noon meeting held by the Spokane Section on Friday, October 14. Mr. Holgren, who is an engineer of the Milwaukee Railroad at Spokane, told of the various types of railroad ties in use for different kinds of service and of several types of experimental ties. His talk was both interesting and instructive.

Utah Section

Business procedure occupied the greater part of the October 7 meeting held by this Section at the University Club in Salt Lake City. Some time was devoted to consideration of the "Model Law for the Registration of Professional Engineers and Land Surveyors," and there was a general discussion of the program of the Reconstruction Finance Corporation and of the various projects which might be developed in Utah and financed by the Reconstruction Finance Corporation loans.

Student Chapter News

Bucknell University

On November 10 the Bucknell University Student Chapter held a meeting at which the principal feature was the presentation of a lecture on the subject of Mississippi River flood control. There were 17 in attendance.

The Rhode Island State College

An address by John V. Keily, Materials Engineer of the Rhode Island State Board of Public Roads, was enjoyed by those present at the November 14 meeting of the Rhode Island State College Student Chapter. Mr. Keily gave a very interesting survey of specifications and tests covering road and bridge building materials, pointing out the benefits to all concerned. An interesting discussion followed.

University of Nebraska

At a meeting of the University of Nebraska Student Chapter, held on November 4, the newly elected president of the Nebraska Section was the principal speaker. His subject was "Steel Pile Foundations for Bridges in Nebraska."

Student Chapter of the University of Nebraska

University of Pennsylvania

A meeting was held by the University of Pennsylvania Student Chapter on November 18. The speaker was Frank O. Dufour, consulting engineer with the U.S. Engineers and Constructors, Inc., who gave a very interesting illustrated address on the "Evolution of a Skyscraper."

Maryland Engineers Relieve Unemployment

During the past year one of the principal responsibilities of the engineering profession has been to provide for the relief of members of the profession and their families who are suffering as a result of the depression. Realizing this, the Maryland Section of the Society took the initiative in organizing the Emergency Relief Committee of Technical Societies in Maryland, Inc.

This committee, which was organized in February 1932, embraced by mutual consent the following engineering and technical organizations: the Maryland Section of the American Society of Civil Engineers; the Baltimore Section of the American Society of Mechanical Engineers; the Baltimore Section of the American Institute of Electrical Engineers; the Engineers Club of Baltimore; the Baltimore Group of the American Society for Steel Treating; the Maryland Association of Engineers; the Maryland Section of the American Chemical Society; the Baltimore Chapter of the American Institute of Architects; and the Baltimore Chapter of the Illuminating Engineering Society.

To date, the committee has succeeded in placing 59 men in some form of remunerative work and has afforded material assistance to a number of others.

Only Signed Ballots Are Counted

Each time that the tellers canvass a letter ballot from the Corporate Members of the Society, it is found that a few members have forgotten to sign their names on the flap of the envelope. According to the rules of canvass, such ballots cannot be counted, but are laid aside and appear in the tellers' report as "ballots unsigned."

There is, of course, no way to discover who are the absent-minded members, so as to send them a duplicate to be properly signed, and if only a dozen such ballots are received, it makes no appreciable difference in the usual canvass. In the preliminary checking of the Ballot for Official Nominees, to be canvassed on January 11, there had been received up to December 22 no less than 50 anonymous envelopes. Members, who have not yet sent in their ballots, are requested to make sure that their names are written—not printed—across the back of the envelope.

Society Appointees

C. W. Hudson, M. Am. Soc. C.E., has been appointed one of the Society's representatives on United Engineering Trustees, Inc., for the three-year term, January 1933–January 1936.

John P. Hogan, M. Am. Soc. C.E., has been appointed Society representative on the Library Board for the term, January 1933–January 1937.

Malcolm Pirnie, M. Am. Soc. C.E., has been appointed to fill the vacancy in the committee in charge of the Freeman Scholarship Awards, caused by the death of John R. Freeman, Hon. M. Am. Soc. C.E.

HERBERT S. CROCKER, President Am. Soc. C.E.; C. E. GRUNSKY, ANSON MARSTON, and FRANCIS LEE STUART, Past-Presidents Am. Soc. C.E.; and ALONZO J. HAMMOND, JOHN P. HOGAN, J. C. HOYT, and CHARLES E. SMITH, Members Am. Soc. C.E., have been reappointed Society representatives on the Assembly of the American Engineering Council for the two-year term, January 1933–January 1935.

THADDEUS MERRIMAN, M. Am. Soc. C.E., has been appointed one of the Society's representatives on the John Fritz Medal Board of Award to fill the vacancy caused by the resignation of Anson Marston, Past-President Am. Soc. C.E.

W. H. CODE, M. Am. Soc. C.E., has been appointed a member of the Executive Committee of the Irrigation Division.

American Engineering Council

National representative of 27 engineering societies, with a constituent membership of 62,000 professional engineers, reports civil engineering news of the Federal Government

President's Message to Congress Has Items of Engineering Interest

In his message to Congress on December 6, President Hoover mentioned in some detail his plans for effecting a reorganization of the Government bureaus. The President stated that he would soon present the necessary executive orders under the recent act authorizing reorganization of the Federal Government, which, if permitted to go into force, would produce substantial economies. On December 9, he presented these orders. The act provides for the grouping and consolidation of 58 executive and administrative agencies according to major purpose, thereby reducing their number, and the consequent overlapping and duplication of effort. The President warned Congress that interested persons inside and outside the Government whose vision is concentrated on some particular function, would at once protest against these proposals and stated that the same sort of activities have prevented reorganization of the Government for over a quarter of a century and that they must be disregarded if the task is to be accomplished.

Executive orders issued for these purposes are required to be transmitted to Congress while in session and do not become effective until after the expiration of 60 calendar days after such transmission, unless Congress shall sooner approve.

The Council has long advocated and supported legislation designed to establish an Administration of Public Works, under which the various engineering functions of the Government would be grouped. The proposals made by President Hoover on December 9 affect the technical branches of the Government service and should be watched with interest by all engineers.

In dealing with the measures necessary to balance the budget for the coming fiscal year, President Hoover stated that the budget as submitted will provide only for the completion of Federal public works projects already undertaken or under contract. He stated that the speeding-up of Federal public works during the past four years as an aid to employment had advanced many types of such improvements to the point where further expansion could not be justified by their usefulness to the Government or the people. He further stated that, as an aid to unemployment, reproductive or so-called "self-liquidating works" should be substituted beyond the normal constructive programs. He called attention to the fact that loans for such purposes had been provided for through the Reconstruction Finance Corporation, and that this kind of project directly relieves the taxpayer and is capable of expansion into a larger field than the direct Federal works. The Federal construction program, thus limited to commitments and work in progress under proposed appropriations, contemplates expenditures for the next fiscal year—including construction of naval and other vessels as well as other forms of public works and the maintenance of them amounting to a total of $442,769,000 as compared with $717,262,000 for the present year.

In touching on other proposed legislation, the President called attention to the fact that he had urged the need for reform in our transportation and power regulation and of the ratification of the Great Lakes–St. Lawrence Seaway Treaty. He stated that these and other special subjects, when necessary, would be dealt with by special communications to Congress.

Reconstruction Finance Corporation

In addition to loans authorized on November 1, which have already been reported, the Reconstruction Finance Corporation authorized 13 loans for self-liquidating projects during the month of November. These loans totaled $4,778,000, bringing the grand total of loans authorized up to and including November 30, to $139,397,500.

Of the 13 loans authorized in November, eight were for construction or extension of water supply systems; two for construction or extension of sewer systems; two for toll bridges; and one for flood control and drainage. The loans ranged in size from $10,000 for a water-works extension in Blackstone, Va., to $1,700,000 for the construction of a toll bridge and repairing of three existing bridges at Richmond, Va.

The hopeful trend toward small, well distributed loans is continuing. The preponderance of loans for water-supply and sewer projects lends evidence to the belief held by many that these two phases of construction work can most easily qualify for loans under the terms of the act. With the convening of state legislatures in January and the possibility of their enacting enabling acts permitting the municipalities of more states to avail themselves of Reconstruction Finance Corporation credit, it may reasonably be expected that this type of loan will show further increase shortly.

Hearings on Great Lakes–St. Lawrence Deep Sea Waterway Treaty

In an effort to prepare for early action by the United States Senate in considering the ratification of the Great Lakes–St. Lawrence Deep Sea Waterway Treaty, promulgated last spring, the Senate Committee on Foreign Relations has recently held extensive hearings in order to obtain information and opinions relating to the treaty. Testimony of a controversial nature was presented at these hearings, which occupied a period of two weeks. The first week was devoted to the presentation of testimony by those opposed to the ratification of the treaty, and the remaining week to the testimony of those who favored its ratification.

Objections to the adoption of the treaty were presented by railroad, maritime, and commercial interests. The provision of the treaty that limits the diversion of water in the Great Lakes system through the Chicago Drainage Canal to 1,500 cu ft per sec, except in times of emergency, resulted in protests from representatives of the Mississippi Valley and Illinois, who claimed that such a limitation would work a hardship on the waterway from the Great Lakes to the Gulf.

The proponents of the treaty marshaled a vast amount of evidence to show the beneficial effect on the Great Lakes area and the country as a whole in the event that the treaty is ratified. Engineers and traffic experts presented evidence to show the practicability of navigation through the proposed route and the economic feasibility of such a route as a means of transportation.

The divergent views presented by those opposed to, and favoring ratification of, the treaty precipitated a discussion in which Senator Borah of Idaho, Committee Chairman, intimated that prospects of a seaway were dim if the present treaty draft were to be rejected.

Federal Power Commission Issues Annual Report

On November 28, the Federal Power Commission issued a memorandum summarizing its annual report and reproducing a section of that report in which the commission proposes certain changes in the Federal Water Power Act. Control of holding companies having relations with licensees of the Federal Power Commission and a more precise definition of the Commission's powers over rates, services, and securities of licensees, as well as extension of authority for cooperation with the states in regulating the interstate transmission of power, are among the proposals made. The commission asks for specific authority to consider "prudent investment" in determining the original cost of a project, and for the right to consider public recreational and scenic features, and matters involving wild life, in dealing with lands valuable for power purposes.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for February

To REUNITE the two parts of the Republic of Panama, severed by the construction of the Panama Canal, and to provide a link in the intercontinental highway, the United States Government has recently completed the Thatcher Highway across the Canal Zone and has provided a free ferry across the Canal itself near Balboa. In an article to appear in the February issue, E. M. Browder, Jr., Jun. Am. Soc. C.E., will describe this construction, especially the novel provision made to handle the traffic on and off the ferry boats, where the tidal variation exceeds 22 ft and where the water surface elevation may change as much as a foot in five minutes.

In another article, H. H. Chapman presents an answer to the question, "Is the natural erosion of land a detriment or a benefit to mankind?" Overgrazing on the public domain has removed the protective cover that prevents erosion, and this in many cases has resulted in the wearing away of as much soil in a generation as was removed in the previous 4,000 years. To quote Professor Chapman, "Engineering works alone will never restore or overcome the widespread destruction of the natural tension between erosion and soil building."

An interesting set of tests on full-sized precast concrete piles was recently completed by John H. Gregory, Robert A. Allton, Members Am. Soc. C.E., and James H. Blodgett, Assoc. M. Am. Soc. C.E., for the city of Columbus, Ohio, to determine their holding-down power. In the design of concrete tanks (a part of the sewage disposal plant located on the bank of the Scioto River) the choice lay between building the floor of the tanks heavy enough to counterbalance the uplift due to the high ground-water level during flood stages in the river, and using a lightweight floor attached to concrete piles driven deep enough to develop resistance to hydrostatic uplift by skin friction. The average resistance to pulling on eight test piles was 582 lb per sq in. of buried depth, enough to warrant the use of piles in the construction of the tanks. The detailed results contained in the coming article describing these tests will be of value to every engineer dealing with the resistance to uplift developed by piles.

Probably the most ancient mention of irrigation that has yet been discovered is that attributed to Hammurabi I, King of Babylon in about 2300 B.C. In most of Mesopotamia and Persia the rains come in the three winter months, and for the remainder of the year the water courses are dry. The ancient irrigators early discovered that in places water underlay large areas and that wells sunk into non-water-bearing strata could be connected to water-bearing gravels by drifts and tunnels. This idea developed slowly until about 800 B.C., when a series of dry wells were connected together with tunnels which finally brought the water to the surface of the ground by gravity. These artificial subterranean canals, called in the Persian "canats," started from the foot hills and collected water from long distances and at considerable depth till it was brought to the surface and the stream led above ground to the land to be irrigated. Little has been written in modern times about these canats, many hundreds of miles of which exist and are in use today. A fascinating account of the extent, use, construction, and cost of these irrigation structures, by M. A. Butler, M. Am. Soc. C.E., is scheduled to appear in the February issue.

Highways, superhighways, parkways, and motor speedways are engaging the attention of motorists, traffic experts, and engineers. The annoyance of being stopped by red traffic lights at every important intersection is being eliminated gradually by separating the grades at points where the density of the traffic and the consequent delay in passing the intersection warrant the expense. In an article on "Separating Grades at Highway Intersections," Herbert S. Swan shows a number of interesting examples of designs which have been used for solving the complicated problem of providing free passage for through and interchange traffic. Notably in New Jersey, the use of the four-leaf clover design of connecting ramps has found favor, and in Westchester County, New York, a large number of interesting highway grade separations have been built, carefully landscaped to maintain the natural beauty of the parkway systems of which they are a part.

Other articles are also in preparation, which together with discussions and items concerning the business of the Society conducted at the Annual Meeting, will make up the February issue of CIVIL ENGINEERING. The succeeding, or March, issue will be devoted to the papers presented at the Annual Meeting.

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BRADFORD ROAD BRIDGE OVER RELOCATED SAWMILL RIVER ROAD AND BRONX PARKWAY EXTENSION

Alloys of Iron and Molybdenum

THE FIRST volume in the series of monographs on the alloys of iron has now appeared. It is the result of the research work of the Alloys of Iron Committee of the Engineering Foundation. Its title, *The Alloys of Iron and Molybdenum*, sufficiently explains its contents. In the preparation of this volume, the technical literature of the world was searched, and all important data were critically examined and correlated. The result is the first comprehensive appraisal of the rôle of a single element in the iron and steel industry.

Although the list price of this book is \$6, a special price of \$5 will be made to members of the Society who place their orders before January 31, 1933. The volume should be ordered from the publisher, the McGraw-Hill Book Company, 330 West 42d Street, New York, N.Y.

Civil Engineering Illustrations Available

FROM TIME TO TIME, requests for the use of illustrations that have appeared in CIVIL ENGINEERING have been received at Headquarters. The Society is always glad to accommodate those who make these requests. In the past, a number of cuts have been loaned, some of them more than once, always of course, with the understanding that when they are used credit will be given CIVIL ENGINEERING and that reference will be made to the issue in which they originally appeared.

The line-cut and halftone blocks for a complete volume of CIVIL ENGINEERING occupy a large amount of valuable storage space, which is needed for other purposes. Because of their aggregate weight it becomes a formidable job to index and handle them. Therefore it has been decided to destroy, on February 1, 1933, all the blocks used in Volume I, that is, those contained in the first 15 issues, beginning with October 1930 and including December 1931.

If the authors of the articles in the first 15 issues, or other readers, desire any of these cuts before they are destroyed, the Society will be pleased to donate them on request to Headquarters. The only charge will be the cost of forwarding the cuts by parcel post or express. First choice will be given authors; then others will be served in the order in which their communications are received. As regards Volume II and the current issues of Volume III, the policy of loaning illustrations will be continued as before. But the cuts in Volume I will not be available after February 1, 1933.

NEWS OF ENGINEERS

From Correspondence and Society Files

J. R. GARDNER has accepted a position as assistant to the Superintendent of Highways of Marshall County, Illinois, with headquarters in Lacon.

EARL L. F. PORTER, formerly a draftsman with the Minnesota State Highway Department, has accepted a connection with the U.S. Engineers in Alma, Wis.

NATHAN I. KASS has resigned his connection with the firm of Nicholas S. Hill, Jr., New York, N.Y., to accept a position as Assistant Engineer in the Engineering Division of the Department of Sanitation, New York, N.Y.

DOUGLAS A. STROMSOE has been appointed Vice-President of the Southern Pipe and Casing Company in Azusa, Calif.

WILLIAM WINSOR PETERSON has accepted a position as draftsman with the Metropolitan District Water Supply Commission of Boston, Mass.

E. L. BARROWS has resigned his position as Chief Hydrographer for the State of New Mexico, to become Assistant Engineer with the U.S. Geological Survey.

GLENN MURPHY, until recently special research graduate assistant in civil engineering at the University of Illinois, has now accepted a position at Iowa State College as an instructor in the department of theoretical and applied mechanics.

FRANCIS W. JOHNSON has resigned his position as district manager of the Raymond Concrete Pile Company and has established a sales office in the capacity of sales engineer at 1740 East 12th Street, Cleveland.

CHESTER K. SMITH, who was formerly special representative to the president of the Union Pacific System, is now an engineer on the Railroad Research Committee, Mississippi Valley Lines.

WILLIAM W. STUDDERT has taken a position as Resident Engineer with the Brooke Construction Company at Langley Field, Va.

E. F. RICE, who was manager of the Guayama, Puerto Rico, office of the Central Machete Sugar Company, is now manager of Central Cortada, Santa Isabel, P.R., for the Central Aguirre Sugar Company.

GEORGE E. DOYEN, who was formerly employed as an engineer with Dwight P. Robinson Company, Inc., of New York, has now been appointed an inspector of building construction in the Division of Engineering of the New York State Department of Public Works.

LEO F. REYNOLDS, who has been employed as Drainage Engineer for the Armco Culvert Manufacturers' Association in Memphis, Tenn., has recently accepted a position with the Tennessee Metal Manufacturing Company of the same city.

GEORGE W. ELSPASS, formerly of Cleveland, Ohio, has accepted a position as sales representative with the Adamson Company, manufacturers of welded products, of East Palestine, Ohio.

R. J. MOORE, JR., has accepted a position with the Texas State Highway Department, with headquarters in San Antonio.

H. J. HASSLER, who was in the employ of the H. K. Ferguson Company of Cleveland, Ohio, in the capacity of assistant chief engineer, has resigned this position to open an engineering office of his own in the same city.

WILLIAM A. FRASER has entered the employ of the Atlantic Refining Company of Cuba, with headquarters in Matanzas.

G. A. BRACHER, formerly County Engineer for the Liberty County (Texas) Highway Department, is now District Engineer, Texas State Highway Department, with headquarters in Beaumont.

GORDON W. PARKHILL, who was formerly an assistant engineer with the H. N. Roberts Company of Lubbock, Tex., has now become an instructor in the Department of Civil Engineering of Texas Technological College, also in Lubbock.

W. F. WAY, formerly a construction engineer with Henry and McFee of Seattle, Wash., is now general manager of the Puget Sound Bridge and Dredging Company and W. F. Way, contractors for the Santa Monica Breakwater, Calif. He is in direct charge of the construction.

ERNST MAAG, who was formerly an engineer in the Pasadena Building Department, is now connected with the Water Department of that city.

G. A. GALLAGHER has resigned his position with the Pacific Tank and Pipe Company, where he was engineer and salesman, to teach in the Department of Engineering, Los Angeles Junior College.

HAROLD A. TAYLOR has accepted a position with the Connecticut Mutual Life Insurance Company of Hartford, Conn.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From November 10 to December 9, 1932

ADDITIONS TO MEMBERSHIP

ATKINSON, FRANK MARSHALL (Assoc. M. '32), R.R. 1, French, N. Mex.

BACCO, LOUIS JOSEPH (Jun. '32), Box 719, Stamford, Conn.

BACKMAN, JOHN EDWARD (Jun. '32), 901 Ackerman Ave., Syracuse, N.Y.

BAIRD, DOUGLAS GEORGE (Jun. '32), 105 East 62d St., Portland, Ore.

BARRON, EDGAR GORDON (Jun. '32), Asst. Engr., U.S. Geological Survey, Water Resources Branch (Res., 153 Fernwood Ave., Colonial Manor), Trenton, N.J.

BATES, ABEL JACOB (Jdn. '32), Thompson Rd., Webster, Mass.

BELZ, CHARLES JOHN (Assoc. M., '32), Asst. Prof., Civ. Eng., Univ. of Dayton, Dayton, Ohio.

BENSCOTER, STANLEY URNER (Jun. '32), 3334 Agnes Ave., Kansas City, Mo.

BIERINGER, FREDERICK ANDREW (Jun. '32), 28 East 17th St., Brooklyn, N.Y.

BLAIN, WILBER ALEXANDER (Jun. '32), 245 South Pitt St., Mercer, Pa.

BODIEN, GORDON EPHRAIM (Jun. '32), 1829 University Ave., S.E., Minneapolis, Minn.

BRADFORD, WILLIAM HARLOW (Jun. '32), Junior Engr., State Highway Comm.; R.F.D. 7, Box 17, Augusta, Me.

BRIDGHAM, MINOT ROBERT SHERMAN (Jun. '32), 646 East 32d St., Brooklyn, N.Y.

BROWN, WALTER AUGUSTUS (Jun. '32), 218 East Center St., Covina, Calif.

BURLEIGH, ALBERT FREDERICK (Jun. '32), 1970 A St., Lincoln, Nebr.

BURRILL, CECIL LLOYD (Jun. '32), Dean's House, Harvard Business School, Soldiers Field, Boston, Mass.

CACACE, LOUIS ROBERT (Jun. '32), 62 Lamartine Ave., Yonkers, N.Y.

CANTINE, THOMAS ROBINSON (Jun. '32), 421 1/2 South 8th, Corvallis, Ore.

CARPIO, GABRIEL DUMLAO (Jun. '32), 48 East 67th St., New York, N.Y.

CASE, CHARLES ROBERT (Jun. '32), Randolph, Ohio.

CHATTERJEE, BIMAL NATH (Assoc. M. '32), Asst. Engr., Commrs. for the Port of Calcutta, Chf. Engr's. Office, Port Commrs., Calcutta, India.

COLICCI, PACIFICO ANTHONY (Jun. '32), 335 Broadway, Providence, R.I.

COUCHERON-AAMOT, WILHELM (Jun. '32), 118 Florence Ave., Irvington, N.J.

CRAMPTON, LAURENCE HARLOW (Assoc. M. '32) Engr.-Contr., R.R. 1, Box 490, Dayton, Ohio.

CROWLEY, LEO FRANCIS (Assoc. M. '32), 12635 Griggs Ave., Detroit, Mich.

CUNNINGHAM, WILLIAM JOHN (Jun. '32), 43 Homecrest Ave., Yonkers, N.Y.

DEKER, FRANK GEORGE (M. '32), Pres., Cruse-Kemper Co., Ambler (Res., 6811 North Carlisle St., Philadelphia), Pa.

DEWITTE, THEODORE RICHARD (Jun. '32), Route 9, Box 410, Portland, Ore.

DIXON, JOSEPH GRUNDY (Jun. '32), 1301 Foulkrod St., Philadelphia, Pa.

EVANS, DANIEL, JR. (Jun. '32), 60 Pleasant Ave., Montclair, N.J.

FAREGH, MOHAMMAD-ALI SAMIIAN (Jun. '32), Care, M. Y. Reihan, Ministry of Finance, Teheran, Persia.

FIDLER, HAROLD ALVIN (Jun. '32), 5842 Sansom St., Philadelphia, Pa.

FINNIE, ALEXANDER GORDON (Assoc. M. '32), Gen. Supt., Fishers Island Corporation, Box 70, Fishers Island, N.Y.

Floras, Christos Lazare (Jun. '32), Engr., Eng. Div., Ministry of Hygiene (Res., 43A Methymnis St.), Athens, Greece.

French, Charles Hottel (Jun. '32), 640 D St., N.E., Washington, D.C.

Gardner, Loyde Harrison (Assoc. M. '32), Dist. Engr., The Ohio Corrugated Culvert Co., 418 Schofield Bldg., (Res., 20545 Morewood Parkway, Rocky River), Cleveland, Ohio.

Gauthier, Raymond Emile (Jun. '32), 618 Eighth Ave., San Francisco, Calif.

Gendron, Roland Arthur (Jun. '32), 110 North 63d St., Philadelphia, Pa.

Hanauer, Monroe Herman (M. '32), Mgr., Los Angeles Branch, Minneapolis Steel and Machinery Div., Minneapolis-Moline Power Implement Co., 818 Chapman Bldg., Los Angeles, Calif.

Hanavan, Eugene Cornelius (Assoc. M. '32), Engr.-Insp., Bureau of Buildings (Res., 540 Manhattan Ave.), New York, N.Y.

Hanson, Arthur Henry (Jun. '32), 56 Winchester Ave., New Haven, Conn.

Hebert, Donald Joseph (Jun. '32), 1111 Woodlawn Ave., Ann Arbor, Mich.

Hipwell, Howard Scott (M. '32), Prin. Asst. Designing Engr., Dept. of City Transit, 1401 City Hall Annex (Res., 6318 City Line Ave.), Philadelphia, Pa.

Houck, Robert Lesher Francis (Jun. '32), R. D. 3, Boyertown, Pa.

Howland, Warren Every (Assoc. M. '32), Asst. Prof., Civ. Eng., Purdue Univ., La Fayette (Res., 106 Connolly St., West Lafayette), Ind.

Hunt, Loren Wilson (Jun. '32), Laboratory Asst., Eng. Materials Testing Laboratory, Univ. of California (Res., 2625 Ridge Rd.), Berkeley, Calif.

Jenny, Arthur Bernhardt (Jun. '32), 128 East Madison Ave., Dumont, N.J.

Jesmain, Burt Gardner, Jr. (Jun. '32), 1467 State St., Schnectady, N.Y.

Jones, Louis Edward (Jun. '32), 5527 Kimbark Ave., Chicago, Ill.

Jorgensen, Roy Ernst (Jun. '32), Junior Highway Engr., U.S. Bureau of Public Roads, 807 Sheldon Bldg., San Francisco (Res., 656 Santa Barbara Rd., Berkeley), Calif.

Kavanaugh, William Francis (Assoc. M. '32), Deputy City Engr. (Res., 120 Mildred Ave.), Syracuse, N.Y.

Keim, Samuel George (Jun. '32), Chainman, State Highway Dept., Box 75, Hammon, Okla.

Kennedy, Robert Baker (M. '32), State Engr., (Res., 518 Sixth St.), Bismarck, N.D.

Knasel, Willis Gerhart (Jun. '32), R. R. 2, Anna, Ohio.

Kochtitzky, Oscar Wilbur, Jr. (Jun. '32), Pi Kappa Phi House, Chapel Hill, N.C.

Koehler, Walter Henry (Assoc. M. '32), With Mexican Petroleum Corporation, 464 Rindge Ave., Cambridge (Res., 99 Mason Terrace, Brookline), Mass.

Kofoid, Orville (Jun. '32), 938 East 10th St., North, Portland, Ore.

Kowitz, Arthur William (Jun. '32), 728 South Center St., Geneseo, Ill.

Krabbe, Jonah Adolph (Jun. '32), Chainman, State Highway Dept. (Res., 404 Oak St.), Bellingham, Wash.

Krishan, Robert Frank (Jun. '32), 4515 North Gratz St., Philadelphia, Pa.

Lagaard, Maurice Bernhart (M. '32), Chf. Engr., Minneapolis Bridge Co., 701 Met. Life Bldg., Minneapolis, Minn.

Last, Irving (Jun. '32), 1867 Sixty-First St., Brooklyn, N.Y.

Levy, George (Jun. '32), 697 Miller Ave., Brooklyn, N.Y.

Lewis, Charles Kimmel (Jun. '32), R.D. 1, Santa Ana, Calif.

Lipp, Maurice Carl (Jun. '32), 108 North Kentucky Ave., Roswell, N.Mex.

Lyons, Robert Stanton (Assoc. M. '32), Asst. Engr., Way Dept., Philadelphia Rapid Transit Co. (Res., 5938 Chester Ave.), Philadelphia, Pa.

MacMurray, John, Jr. (Jun. '32), West Milford, N.J.

McElroy, Wyllys Fields (Jun. '32), 5000 Beard Ave., South, Minneapolis, Minn.

McQueen, James Milton, Jr. (Jun. '32), Eng. Aid., U.S. Dept. of Agriculture (Res., 4330 Chesapeake St., N.W.), Washington, D.C.

Marson, Frank Milo (Jun. '32), 1113 Amsterdam Ave., New York, N.Y.

Matsui, Yasuo (M. '32), Pres., F. H. Dewey & Co., 350 Fifth Ave., New York, N.Y.

Michel, Frederick John (Jun. '32), Main St., Springville, N.Y.

Michels, William (Assoc. M. '32), Engr. and Contr., 4204 Oneida Ave., New York, N.Y.

Molnar, Louis Andrew (Jun. '32), Eng. Asst., Grade 3, Board of Transportation (Res., 45-36 Thirty-Ninth Pl., Sunnyside, Queens), New York, N.Y.

Morales, José Dionisio (Assoc. M. '32), Prof. of Math., Coll. of Agriculture and Mech. Arts, P.O. Box 882, Mayaguez, Puerto Rico.

Nelson, John Geoffrey (Jun. '32), H-2, Dimon Court Apartments, Columbus, Ga.

Netland, Theodore Jaél Bugge (Jun. '32), Asst. Hydrographer, East Bay Municipal Utility Dist.; 116 North Pleasant Ave., Lodi, Calif.

Obermann, Robert Frank (Jun. '32), 153 Plauderville Ave., Garfield, N.J.

O'Brien, George Francis (Assoc. M. '32), Draftsman, W. H. Gahagan, Inc., 97-19 Thirty-Fifth Ave., Corona, N.Y.

Oliszewski, Casimir (Jun. '32), 1815 West Mitchell St., Milwaukee, Wis.

Perry Paul Clutter (Jun. '32), Box 146, Little River, Kans.

Pesce, Carl Anthony (Jun. '32), Structural Steel Designer, Board of Transportation, New York (Res., 1700 West 4th St., Brooklyn), N.Y.

Pickering, Harold Phillip (Jun. '32), Kincaid, Kans.

Quam, Elmer Raymond (Jun. '32), 413 Spruce St., Boulder, Colo.

Reindollar, Robert Mason (M. '32), Asst. Chf. Engr., State Roads Comm., Federal Reserve Bank Bldg., Baltimore, Md.

Romaniello, Carmine James (Jun. '32), 89 Pilgrim Ave., Waterbury, Conn.

Ross, Harry Stegner (Jun. '32), 3434 Michigan Ave., Cincinnati, Ohio.

Sawtelle, Egerton Burpee (Jun. '32), 55 Capitol St., Augusta, Me.

Schmidt, Milton Elmer (Jun. '32), 3434 Newton Ave., North, Minneapolis, Minn.

Schmucker, Leroy Leland (Assoc. M. '32), Asst. Mgr., First-Central Trust Co. (Res., 101 Hamilton Ave.), Akron, Ohio.

Schofield, Louis (Jun. '32), 883 Franklin Ave., Brooklyn, N.Y.

Schuleen, Emil Philip (Assoc. M. '32), Asst. Engr., U.S. Engr. Office, Pittsburgh, Pa.

Schumann, George Edgard (Assoc. M. '32), Designer, Arthur G. McKee Co. (Res., 1196 Bender Ave.), Cleveland, Ohio.

Seabrook, Charles Courtney (Jun. '32), Polk Lane, Bridgeton, N.J.

Seghers, Guy Joseph (Assoc. M. '32), Civ. Engr. and Surv. (Ricketts, Seghers & Dibdin), 809 Audubon Bldg., New Orleans, La.

Shoemaker, Theodore (Assoc. M. '32), Pres., Northwest Roads Co., Craig and Warren Rds., Portland, Ore.

Showell, Carter Seddon (Jun. '32), 1448 Bryan Ave., Salt Lake City, Utah.

Silliman, Julian Winthrop (Jun. '32), Wheaton Springs, via Nipton, Calif.

Sims, John Peter (Jun. '32), New Boston, Pa.

Smith, Robert Chalfin (Jun. '32), California Inst. of Technology, Norman Bridge Laboratory of Physics, 1201 East California St., Pasadena, Calif.

Speiden, Edgar French (Jun. '32), 206 Roger St., Bluefield, W.Va.

Stockelberg, John Gerald (Assoc. M. '32), Engr., Raymond Concrete Pile Co.; Box 68, Ancon, Canal Zone.

Stroyan, Robert (Jun. '32), Milford, Pa.

Thielhelm, Harold William (Jun. '32), 556 West 161st St., New York, N.Y.

Throckmorton, James Sansbury, 3d (Jun. '32), 31 Hanford Pl., Caldwell, N.J.

Ward, Charles Elverton (Jun. '32), 14 Maple Drive, Great Neck, N.Y.

Warnecke, Robert Irving (Jun. '32), 693 St. John's Pl., Brooklyn, N.Y.

White, Harry Edwin (Jun. '32), Penrose, Colo.

Whitsit, Lawrence Cousins (Jun. '32), 110 California Ave., Highland Park, Mich.

Willard, Roger Hersperger (Jun. '32), Burkittsville, Md.

Membership Transfers

Alvarez y de Urrutia, Armando Manuel (Jun. '20; Assoc. M. '24; M. '32), Mgr. and Chf. Engr., Lima Office, Frederick Snare Corporation, Apartado 1399, Lima, Peru.

Anderson, Willard Aron (Jun. '28; Assoc. M. '32), Asst. Maintenance Engr., Govt. Printing Office (Res., 7019 Georgia Ave., N.W., Apartment 305), Washington, D.C.

Baker, Arvid Harry (Jun. '28; Assoc. M. '32), Asst. Engr., Research and Tests Section, Design Div., The Port of New York Authority, 80 Eighth Ave., New York, N.Y. (Res., 18 Lincoln Ave., Wood-Ridge, N.J.)

Davis, Calvin Victor (Assoc. M. '25; M. '32), Chf. Designer, Ambursen Dam Co., Inc., 295 Madison Ave., New York, N.Y.

Finke, Ralph William (Jun. '27; Assoc. M. '32), Bridge Designer, State Dept. of Highways (Res., 2012 Adams St.), Olympia, Wash.

Fitch, John Douglass (Jun. '26; Assoc. M. '32), Engr., Associate, Am. Eng. Council, 744 Jackson Pl., N.W., Washington, D.C.

Fleming, Eric (Jun. '23; Assoc. M. '24; M. '32), Archt. and Engr., 209 Townsend St., New Brunswick, N.J.

Fox, Frederick Carl, Jr. (Jun. '31; Assoc. M. '32), Asst. Civ. Engr., State Dept. of Public Works, Div. of Highways, Dist. 8 (Res., 287 Mill St.), Poughkeepsie, N.Y.

Gordon, Bennett Taylor (Jun. '29; Assoc. M. '32), Designer, Strauss Eng. Corporation, 307 North Michigan Ave. (Res., 925 Montrose Ave.), Chicago, Ill.

Joyce, Walter Edward (Assoc. M. '14; M. '32), Pres. and Chf. Engr., The W. E. Joyce Co., Inc. (Res., 375 Albany Ave.), Kingston, N.Y.

Langford, Leonard Lionel (Jun. '30; Assoc. M. '32), Engr., Pacific Flush-Tank Co., 136 Liberty St., Room 606, New York, N.Y.

Li, Shu-T'ien (Jun. '26; Assoc. M. '32), Executive Member and Chf. Secy., North China River Comm., Italian Concession (Res., No. 14, Yung Ho Li, Singapore Rd., British Concession), Tientsin, China.

McCreery, Donald Hull (Jun. '22; Assoc. M. '32), Engr. and Gen. Supt., Richards-Neustadt Const. Co.; 1280 Afton St., Pasadena, Calif.

Moseley, Harry Heber (Jun. '28; Assoc. M. '32), Asst. Civ. Engr., George B. Gascoigne, 1140 Leader Bldg., Cleveland, Ohio.

Newman, Harry (Jun. '23; Assoc. M. '32), Asst. Section Engr., Board of Transportation, 250 Hudson St., New York (Res., 786 East 34th St., Brooklyn), N.Y.

Noyes, Haydon Thom (Jun. '31; Assoc. M. '32), with Turner Constr. Co., 420 Lexington Ave., New York (Res., Odell Court, New Rochelle), N.Y.

Stafford, Julian Tate (Jun. '25; Assoc. M. '32), Structural Engr., Henry D. Dewell, San Francisco (Res., 2427 Hilgard Ave., Berkeley), Calif.

Stauffer, Isaac Yost (Jun. '16; Assoc. M. '19; M. '32), Engr. in Chg., Standard Oil Co. of New York, P.O. Box 404, Yokohama, Japan.

Straus, Herman Louis (Jun. '24); Assoc. M. '32), Engr., Chicago Bridge & Iron Works, 1305 West 105th St., (Res., 7344 South Shore Drive), Chicago, Ill.

Thacker, Gerald Quincy (Jun. '27; Assoc. M. '32), Engr., Civ. Eng. Section, Gen. Eng. Dept., Standard Oil Co. of California, 225 Bush St., San Francisco (Res., 2312 McGee Ave., Berkeley), Calif.

Van den Broek, John Abram (Assoc. M. '17; M. '32), Prof., Eng. Mechanics, Univ. of Michigan (Res., 715 Forest Ave.), Ann Arbor, Mich.

Reinstatements

MOORE, LESLIE DOMINICK, M., reinstated Nov. 19, '32.

WOODBRIDGE, CYRIL JAMES, JUN., reinstated Nov. 10, '32.

Resignations

ANDREEN, GUSTAF BIRGER, Assoc. M., resigned Nov. 17, '32.

BLACKBURN, GEORGE BLAIR, Jun., resigned Nov. 22, '32.

EVERETT, RALPH BURROWS, Assoc. M., resigned Nov. 9, '32.

HARMAN, JOHN JAMES, M., resigned Nov. 9, '32.

KERANEN, GEORGE MATTHEW, Jun., resigned Nov. 25, '32.

KERN, FRANCIS XAVIER, Assoc. M., resigned Nov. 9, '32.

MCLURE, NORMAN ROOSEVELT, M., resigned Dec. 5, '32.

MOHR, WILLIAM HENRY, Assoc. M., resigned Nov. 14, '32.

ROBERTSON, GORDON JAMES, JUN., resigned Nov. 18, '32.

ROGERS, GEORGE EDWIN, Assoc. M., resigned Dec. 3, '32.

STRAUSS, SYDNEY MARTIN, Jun., resigned Dec. 5, '32.

WINTER, HUGO HERMAN, Assoc. M., resigned Nov. 14, '32.

Deaths

ANDERSEN, CHRISTIAN. Elected M., Jan. 2, 1901; died Nov. 18, 1932.

CHAMBERS, FRANK TAYLOR. Elected Assoc. M., April 6, 1898; M., Mar. 3, 1903; died Nov. 10, 1932.

FEHÉR, FRANCIS. Elected Assoc. M., Mar. 5, 1928; died Apr. 30, 1932.

GARDINER, JOHN PEDEN. Elected Assoc. M., Mar. 7, 1906; M., Sept. 6, 1910; date of death unknown.

HADLEY, EVERETT ADDISON. Elected M., Oct. 11, 1920; died Nov. 11, 1932.

MACGLASHAN, ALEXANDER. Elected M., Mar. 12, 1918; died Dec. 6, 1932.

REINKE, FREDERICK JARRETT. Elected M., July 2, 1913; died Aug. 30, 1932.

SHAW, SUMNER FARNHAM. Elected M., Oct. 3, 1894; died Nov. 18, 1932.

THOREN, ROY JOYCE VINCENT. Elected Jun., Oct. 14, 1929; died Aug. 10, 1932.

YORK, HERBERT WALDO. Elected Jun., May 2, 1888; M., June 3, 1896; died Nov. 21, 1932.

TOTAL MEMBERSHIP AS OF DECEMBER 9, 1932

Members	5,824
Associate Members	6,304
Corporate Members	12,128
Honorary Members	19
Juniors	2,927
Affiliates	117
Fellows	5
Total	15,196

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1932 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

Construction

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 31; married; Columbia graduate; 3 years drafting experience on structural layouts, track layout, and machine detailing; 1 year in South America. Speaks Norwegian and German fluently, Spanish fairly well. Desires position with construction company or contractor. Location and immediate salary immaterial. D-1748.

Design

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 45; with 25 years experience in structural and mechanical lines, including the design, checking, and detailing of structural steel for office, apartment, and mill buildings, and the design, detail, and construction of coal and ash-handling plants and equipment. Location New York and vicinity. A-3807.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; graduate of Polytechnic Institute of Brooklyn; special course in structural engineering; 9 1/2 years experience as a structural steel and reinforced concrete designer and detailer for all types of structures; excellent draftsman and designer; checker of shop drawings. Available immediately. Location preferably Eastern states. D-1754.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; B.S., Norwich University; graduate courses, Brooklyn Polytechnic Institute; 1 1/2 years in field on subaqueous construction and rock tunnel, concrete, and steel construction; 4 years in design and drafting on large suspension bridge, steel arch, and vehicular tunnel. Familiar with all phases of design. Location immaterial. Available immediately. D-1665.

DESIGNER; Assoc. M. Am. Soc. C.E.; 31; married; graduate of Lehigh University, 1924; 1 year in graduate school of University of Illinois; 7 1/2 years broad experience in drafting and designing. Some field work. Capable designer of rigid-frame bridges and indeterminate structures, highway bridges, and industrial plants. Location immaterial. C-7922.

PULP AND PAPER MILL DESIGN AND CONSTRUCTION; Assoc. M. Am. Soc. C.E.; 34; married; graduate structural engineer; 8 years experience in the design and construction of cellulose plants. Complete detailed layouts of paper mills. Speaks Russian fluently. Naturalized. Available now. Location, anywhere. D-119.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; married; graduate; state licenses; 10 years experience, surveying, design, and construction. Design, detail, and preparation of plans and specifications, on railroad, highway, parkway, harbor, and tall building structures. Completely familiar with the design of rigid-frame bridges. Available immediately. D-1496.

Executive

HIGHWAY ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; 2 years experience in railroad maintenance-of-way work and location; 12 years experience in all phases of highway engineering—location, drafting, plan design, and construction—pavements. Available for work in any capacity. Location in South preferred, but will go anywhere. D-865.

CIVIL OR HYDRAULIC ENGINEER; M. Am. Soc. C.E.; 36; married; 11 years experience—9 in responsible charge of hydraulic and structural design of sewerage works costing about $24,000,000, and experimenting, investigating, reporting, writing specifications, and preparing estimates for sewer contracts. Also 2 years varied construction experience. Available at once. Location immaterial. D-1132-326-A-7 San Francisco.

SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; 34; graduate in sanitary engineering; licensed California; 11 years experience with responsible charge in design, construction, and operation of water and sewage-treatment plants and systems. Also field and laboratory experience with state board of health. Location and salary secondary. Available immediately. D-1714.

CIVIL AND MECHANICAL ENGINEER; Assoc. M. Am. Soc. C.E.; technical education; New York State license; 20 years experience; design, construction, maintenance, contract sales, management; power and industrial plants, mechanical handling and storage plants, railroad and contractor's equipment, and steel structures. Open for responsible position. B-4537.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience; drafting, design, and construction; inspection, surveys, layouts, checking, estimating, and related work. Readily adaptable to new conditions and methods. Desires connection of any kind in field or office; also sales-engineering or instructorship. C-2605.

STRUCTURAL AND PUBLIC UTILITY CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; 2 years on county bridges and highways; 3 years drafting, designing, and estimating, all types of buildings; 3 years in design and construction of oil refinery; 7 years as civil engineer for public utilities organizations on tower lines, buildings, substations, power houses, and boiler plants. C-9070.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 30 years experience, chiefly specializing in food markets, cold storage, and refrigeration; has had considerable experience as general manager for sales division of electric refrigerators, domestic and commercial. D-1516.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 25 years experience in design and construction of steam and hydro-electric power plants, transmission lines of all capacities, including 220,000 volts, industrial plants, electric railways, valuations, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; New York State license; 15 years field and office; experienced in design of office and industrial buildings and flat-slab factory buildings. Municipal experience in bridges, water works, paving, and building inspection. Had responsible charge of writing contracts and specifications, also supervision of appraisals. Location immaterial. D-1729.

HYDRAULIC ENGINEER; M. Am. Soc. C.E.; 37; married; university graduate; 15 years experience, largely on hydro-electric developments. In charge of numerous preliminary investigations, large projects, domestic and foreign, including surveys, river discharge gagings and studies, subsurface investigations, power output estimates, cost estimates, and complete reports. Also experienced in design and construction. Available immediately. Location secondary. C-9694.

CIVIL AND INDUSTRIAL ENGINEER; M. Am. Soc. C.E.; graduate; licensed. Design, construction, and rehabilitation of industrial plants of all kinds, warehouses, hydro-electric developments, housing groups, commercial garages, etc. Organization of office and field staffs, and supervision and direction of office and field forces. B-2835.

MUNICIPAL ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; 10 years experience in paving; sewer, water-works, bridge, and electrical construction; and in the operation of various departments connected with municipal government. Available immediately. D-1755.

HYDRAULIC ENGINEER; Assoc. M. Am. Soc. C.E.; 34; master of science degree; particularly experienced in hydraulic investigations, cost estimates, and the writing of reports. C-1334.

Construction-Civil Engineer; Assoc. M. Am. Soc. C.E.; 31; married; 11 years experience in surveys, design, estimates, construction of sewers, water systems, and paving. Last 3 years in responsible charge of construction of $1,600,000 sewer and paving contract in South America. Can relieve contractor or engineer of details. Desires responsible position with contractor or consulting engineer. Location immaterial. D-1757.

Junior

Civil Engineer; Assoc. M. Am. Soc. C.E.; 28; single; M.E. and C.E.; New York State licenses; 7 years of varied experience in surveying, estimating, and design of railroad and highway bridges, buildings, and subways. Desires position with a consulting engineer or contractor. Available immediately. C-2325.

Junior Civil Engineer; Jun. Am. Soc. C.E.; 22; single; B.S. in C.E. (hydro-electric option) from Massachusetts Institute of Technology; 2 summers experience tracing and drafting mill-building construction plans and equipment details; working knowledge of German; willing to travel; location immaterial. D-1697.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; C.E. degree from Rensselaer Polytechnic Institute. Neat and accurate draftsman. Thoroughly experienced in uses of transit, level, plane table, and hand level. Surveying computations a specialty. Diligent and willing worker. Location and salary immaterial. References. C-9793.

Civil Engineer Graduate; Jun. Am. Soc. C.E.; 21; honor graduate of Syracuse University in June 1932; 6 months experience in drafting and surveying. Wants position in any branch of civil engineering, preferably structural. References. Location immaterial. Available immediately. D-1705.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; degree of master of engineering, 1927; 3 years with contractors on large dock and dam projects in office and field; 2 years in port-authority office on design of long-span suspension bridge and vehicular tunnel; 8 months as resident engineer in the construction of an oil refinery. Any locality. Speaks French, German, and Spanish. D-457.

Civil Engineer; Jun. Am. Soc. C.E.; 22; recent graduate; good record; strong and willing to work; knowledge of stenography. Will go anywhere; do anything. Salary secondary. Desires experience. D-1732.

Civil Engineer; Jun. Am. Soc. C.E.; 21; single; B.S. in C.E., University of California, 1931. Passed U.S. Civil Service Examination for Junior Engineer, with Coast and Geodetic Survey; one years experience in office; one summer of field experience, California Highway Commission. Good college record, especially in highway subjects. Desires work in civil engineering. Location immaterial. D-1751.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; C.E. 1929, Rensselaer Polytechnic Institute; 2 years in bridge construction, New York State Highway; 1 year teaching civil engineering subjects; 3 months as timekeeper on bridge construction. Construction, design, or teaching position desired. Location immaterial. C-7263.

Sales

Engineer and Executive; Assoc. M. Am. Soc. C.E.; 43; with established sales office in Cleveland, Ohio; would like to give part time directing sales, or possibly handling operations, in Cleveland and vicinity, in connection with a proposition offering good sales possibilities, or would like to contact company desiring Cleveland connection. D-1024.

Structural Engineer Executive; M. Am. Soc. C.E.; 45; married. Over 20 years experience in estimating and sales for modern structural steel fabricating business. Well acquainted with sales in western Pennsylvania and Ohio. Has specialized in efficient handling of estimating and competition design. C-5095.

Structural Engineer; M. Am. Soc. C.E.; sales executive; experienced in designing structural steel and ornamental iron for both riveted and welded construction; experienced in estimating, costs, burden application, and sales. B-7445.

Structural and Sales Engineer; Assoc. M. Am. Soc. C.E.; 39; married; graduate. High-class sales executive. Long experience in sales, sales management, designing, detailing, and estimating bridges and buildings. Seeking connection with building material manufacturer or distributor, also engineering position with general contractor. Available immediately. Capable and forceful. D-16.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

The Early Years of Modern Civil Engineering. By Richard Shelton Kirby and Philip Gustave Laurson. New Haven, Yale University Press, 1932. 324 pp., illus., $9^1/_2 \times 6^1/_2$ in., cloth, $4.

A fascinating compilation of material relating to pioneer engineering work in Europe and America during the eighteenth century and part of the nineteenth. Among the subjects covered are surveying, canals, roads and pavements, railroads, bridges, tunnels and subways, and sewers.

Economics of Construction Management. By J. L. Harrison. Chicago, Gillette Publishing Company, 1932. 330 pp., charts, tables, 8 × 6 in., cloth, $3.75.

The author of this work, who is connected with the Division of Management of the U.S. Bureau of Public Roads, discusses the economics of management upon the basis of his studies for the bureau and his experience as supervisor and engineer-in-charge of construction. Accounting, cost control, production, labor, materials, operating expenses, depreciation, and similar items are treated.

Forschungsheft 356. Gesetzmässigkeiten der Turbulenten Strömung in Glatten Rohren. By J. Nikuradse. Berlin, VDI-Verlag, 1932. 36 pp., illus., diagrs., charts, tables, 12 × 8 in., paper, 5 rm.

This report covers experiments made in Goettingen during 1928 and 1929, under the direction of Dr. Prandtl, for the purpose of extending our knowledge of turbulent flow by experiment with very large Reynolds numbers and of throwing light upon the relation between the Reynolds number, the law of resistance, and the velocity distribution. The results are given in full, with the conclusions deduced from them.

Forschungsinstitut für Wasserbau und Wasserkraft, München. Mitteilungen, Heft 2. Munich and Berlin, R. Oldenbourg, 1932. 64 pp., illus., diagrs., charts, tables, 11 × 8 in., paper, 4.80 rm.

The four papers here presented discuss, from various points of view, the problem of strengthening and waterproofing canals and ditches. The merits and demerits of clay and concrete linings are discussed briefly in the first paper. The second is a report upon extensive experiments with tar and asphalt linings. The third paper discusses the hydraulic characteristics of an asphalt-lined experimental canal, and the fourth is a general account of the use of asphalt in construction.

Handbuch der Geophysik. Band 2, Lieferung 2. Ed. by B. Gutenberg. Der geologische Aufbau der Erde. By A. Born. Berlin, Gebrüder Borntraeger, 1932. pp. 565–867, diagrs., maps, 11 × 7 in., paper, subscription price 46 rm.; price of single number 69 rm.

This handbook of regional geology provides an objective review of our knowledge of the geological structure of the earth. Professor Born has endeavored to include all late information in his summary. The entire earth is covered and the facts given as completely, although concisely, as possible. Numerous maps and references are included.

Highway Research Board. Proceedings 11th Annual Meeting, Washington, D.C., December 10–11, 1931. Part 1, Reports of Research Committees and Papers, 443 pp.; Part 2, Report of Investigations Upon Use of Rail Steel Reinforcement Bars in Highway Construction, 91 pp. Washington, D.C., National Research Council, 1932. illus., diagrs., charts, tables, 10 × 7 in., paper, $2.

The principal item in this volume is the report of an extensive investigation of the use of steel rail reinforcement bars in highway construction. In addition, there are presented the reports of the research committees and a number of technical papers dealing with problems of highway finance, transportation, design, materials, construction, maintenance, and traffic.

Home Ownership, Income and Types of Dwellings. Edit. by J. M. Gries, J. Ford and J. S. Taylor. Washington, D.C., President's Conference on Home Building and Home Ownership, 1932. 230 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $1.15.

The three reports in this volume discuss various phases of the problem of home ownership—the relative social and economic merits of ownership and renting; the relation of income to housing; the varieties and types of dwellings and their relative merits and costs. A large amount of statistical data of interest to contractors, architects, and householders is presented.

Housing and the Community—Home Repair and Remodeling. Ed. by J. M. Gries and J. Ford. Washington, D.C., President's Conference on Home Building and Home Ownership, 1932. 291 pp., illus., maps, charts, tables, 9 × 6 in., cloth, $1.15.

The first report in this volume discusses the relation of housing to community health, delinquency, the efficiency of working men, and related matters. The second report deals practically with the reconditioning, remodeling, and modernization of houses.

Man and Metals. By T. A. Rickard. 2 vols. New York & London, McGraw-Hill Book Co. (Whittlesey House), 1932. 1068 pp., illus., diagrs., maps, 9 × 6 in., cloth, $10.

A valuable history of mining, from the earliest times to the present, and the part that mining has played in the development of civilization. The story of man's struggle to master the mineral resources of the world is carefully developed, and students of mining, of history, and of society will find the work useful. At the same time, the general reader will find it readable and full of interest.

Materials and Methods of Architectural Construction. By C. M. Gay and H. Parker. New York, John Wiley and Sons, 1932. 639 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $6.

The authors of this book believe that better results are obtained by treating the subjects of materials and methods together, instead of individually. Such a presentation is developed in this text, which gives concise information about the materials in general use and the accepted methods of using them.

Mechanical Testing. Vol. 1. Testing of Materials of Construction. (D. U. Technical Series.) By R. G. Batson and J. H. Hyde. 2 ed., New York, E. P. Dutton and Company, 1931. 465 pp., illus., charts, diagrs., tables, 9 × 6 in., cloth, $6.50.

This work is intended to inform engineers manufacturers, and students concerning the conditions that govern the testing of structural materials, to give them particulars about the standard testing plant and its limitations, and to provide information that will enable them to interpret correctly the results of tests. The new edition has been revised to conform with the specifications of the British Engineering Standards Association, and the chapters on fatigue and hardness testing and testing at high temperatures have been enlarged.

Technische Kulturdenkmale im Auftrag der Agricola - Gesellschaft beim Deutschen Museum. By C. Matschoss and W. Lindner. München, Verlag F. Bruckmann A. G., 1932. 127 pp., illus., 12 × 9 in., cloth, $1.65. (Stechert.)

Brief essays upon the evolution of engineering, accompanied by a remarkable series of photographs of specimens of early bridges, machines, workshops, and similar features, which are still in existence in Germany. An attractive work of considerable historic interest.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Australia. Road Bridge Over Snowy River, Woolgoolmerang, Vic., M. G. Dempster. *Commonwealth Engr.*, vol. 20, no. 2, Sept. 1, 1932, pp. 33–39. Design and construction of highway bridge, 750 ft long, consisting of 6 Warren-type trusses, up to 135 ft in length; details of welded joints; cost data.

Bascule, Floors. Open-Mesh Steel Deck for Seattle Bascule. *Eng. News-Rec.*, vol. 109, no. 21, Nov. 24, 1932, p. 624. Remodeling of the University Avenue Bridge in Seattle, Wash., to provide it with more roadway capacity; open-mesh steel deck on bascule span effects weight-saving of 16 lb per sq ft over the lightest alternative design made, and permits addition of extra vehicle lanes outside bascule trusses without strengthening the trusses themselves.

Concrete Arch. Check Levels Made on Fort Snelling—Mendota Bridge, W. H. Wheeler. *Eng. News-Rec.*, vol. 109, no. 13, Sept. 29, 1932, p. 371 (discussion), vol. 109, no. 17, Oct. 27, 1932, p. 507. Observations on highway bridge consisting of 12 full arch spans 304 ft from center to center; levels, taken on sidewalks of bridge before it was opened in 1926 and again recently, reveal that no pier settlement has occurred and that flow in concrete, if any, has not been important.

Design. Ideal Bridge, A. W. Legat and G. Dunn. *Concrete and Constr. Eng.*, vol. 27, no. 10, Oct. 1932, pp. 551–559. Study of ancient and modern highway bridges in England; author favors concrete bridge construction.

India. Willingdon Bridge Calcutta, R. Mair. *Inst. Civ. Engrs.—Excerpts Min. Proc.*, vol. 235, session 1932–1933, part 1, paper no. 4880, 1932, 56 pp., 2 supp. plates. Design and construction of steel-truss railroad bridge consisting of seven spans totaling 2,511 ft in length, resting on brick piers, founded on caissons 70 by 37 ft, and sunk to an average depth of from 120 to 130 ft below mean sea-level; sinking of caissons; flotation of main spans; service girders; positioning of span; expansion arrangements; track and roadways; test loading of main spans costs.

Ireland. Mountgarrett Bridge, J. K. Maconchy. *Inst. Civ. Engrs. Ireland—Trans.*, vol. 58, 1931–1932, pp. 147–198 (discussion) 199–231, 3 supp. plates. Design and construction of concrete girder bridge, 210 ft total length, with concrete spans up to 29.5 ft, including 47-ft steel span of bascule design.

Lift. Duluth's Aerial Lift Bridges, J. Wilson. *Military Engr.*, vol. 24, no. 138, Nov.-Dec. 1932, pp. 588–591. Construction and operation of new lift bridge having clear height of 135 ft; length of span 386 ft.

Plate Girder, Reconstruction. Replacing Plate-Girder Bridges by Inverting Spans, T. Kuroda. *Eng. News-Rec.*, vol. 109, no. 17, Oct. 27, 1932, p. 497. Japanese method, requiring no falsework; new span is placed upside down on top of old span and fastened together, then inverted about longitudinal axis of both, and set in correct position.

Pontoon. Floating Swing Spans for Railroad Bridges. *Ry. Eng. and Maintenance*, vol. 28, no. 11, Nov. 1932, pp. 674–677. Construction operation, and maintenance of pontoons in two river crossings of the Chicago, Milwaukee, St. Paul and Pacific, between Wabasha, Minn., and Trevino, Wis., and between Marquette, La. and Prairie du Chien, Wis.; span lengths ranging from 209 to 396 ft; locking mechanism; mitered rail joints; bridge tenders.

Steel Arch, Construction. Bridge Erected by Combination of Gin Poles and Derricks, H. E. Robertson. *Construction Methods*, vol. 14, no. 10, Oct. 1932, pp. 28 and 29. Erection of two 149-ft unsymmetrical steel bowstring arch spans across the Los Angeles River, at Los Angeles forming a part of the Sixth Street Viaduct.

Steel Truss, Siam. Bangkok Memorial Bridge. *Civ. Eng. (Lond.)*, vol. 26, no. 315, Sept. 1932, pp. 15–17 and 19. Features of highway bridge, 750 ft long, with two spans, 247 ft each, in addition to a central opening of 196 ft spanned by double-leaf bascule, electrically operated; cost 255,000; provision for hand operation; lowering of caissons.

Steel, Welding. Construction and Strengthening of Bridges by Electric Arc Welding, E. D. Lacey. *Civ. Eng. (Lond.)*, vol. 26, no. 315, pp. 39 and 41–43. Review of recent practice, with examples from Australia, Europe, and Asia.

Trusses, Design. Analysis of Secondary-Stresses in Bridge Truss by Principle of Least Work, Loho. *Science Soc. China—Trans.*, vol. 7, no. 3, 1932, pp. 271–309. Redundant members in Pratt truss; unknown quantities to be found; principle of least work and its application; formula for Pratt truss of six panels and formulation of numerical equations; solution of equations. (In English.)

BUILDINGS

Earthquake Effects. Earthquake-Resistant Construction—Its Status Today, B. Willis. *Eng. News-Rec.*, vol. 109, no. 18, Nov. 3, 1932, pp. 532 and 533. Unity of construction and rigidity of structure understood to be fundamental to safety; height limitations as related to rigidity; place of flexible construction and its application to Olympic Club Building.

Exhibition Buildings, Chicago. Some Types of Buildings at World's Fair, C. W. Farrier. *West. Soc. Engrs.—Journal*, vol. 37, no. 5, Oct. 1932, pp. 241–249 (discussion) 249–250. New types of buildings, low in cost and distinctive in architecture, erected for Century of Progress Exposition; utilizing ready-made materials requiring no fabrication in field; possibilities for low-cost permanent housing.

High Buildings, United States. Evolution of High Building Construction, C. T. Purdy. *West. Soc. Engrs.—Journal*, vol. 37, no. 4, pt. 1, Aug. 1932, pp. 201–209 (discussion) 209–211; see also correction in vol. 37, no. 5, Oct. 1932, p. 258. Evolution of skyscrapers in United States.

New York City. Organization and Construction Supervision for Rockefeller Center. *Eng. News-Rec.*, vol. 109, no. 20, Nov. 17, 1932, pp. 598 and 599. Organization and progress-of-construction charts.

Philadelphia. Building Façade Emphasizes Steel Frame. *Eng. News-Rec.*, vol. 109, no. 19, Nov. 10, 1932, pp. 549–552. Design and construction of Philadelphia Savings Fund Society Building, which is the tallest building in Philadelphia, having 33 stories with a floor area of 565,000 sq ft, costing about $8,000,000; building presents new architectural concepts and includes cantilever walls and 60-ft span trusses carrying the upper 30 stories; wind design; special details.

Radio Center, New York City. RCA Building of 69 Stories Rivals Empire State. *Eng. News-Rec.*, vol. 109, no. 20, Nov. 17, 1932, pp. 587–590. Central unit of Rockefeller Center, notable for its slab-shaped tower, about 100 by 325 ft in plan; both steel tonnage and rentable area greater than in world's tallest structure; power plant; wind design; graduated wind pressures; wind connections.

CIVIL ENGINEERING

Egypt. Egypt and Sudan, M. MacDonald. *Engineer*, vol. 154, no. 4008, Nov. 4, 1932, pp. 460 and 461. Review of engineering developments; series of works known as Delta Barrage completed in 1861; heightening Assuan Dam; other projects; developments of Gezira region by construction of Sennar Dam. Before Inst. Civ. Engrs.

CITY AND REGIONAL PLANNING

California. Unemployed Aid Regional Planning in Los Angeles County, C. H. Diggs. *City Planning*, vol. 8, no. 4, Oct. 1932, pp. 222–227. Director of the Regional Planning Commission of Los Angeles County reports on purposes, methods, and results of traffic count, study of community business centers, industrial surveys, park designs, and similar items.

Germany. Development of City Planning in Germany, J. Nolen. *City Planning*, vol. 8, no. 4, Oct. 1932, pp. 209–215. Review of progress made in successful city planning in Germany; sources of city-building success; provisions for recreation.

New Zealand. Some Fundamentals for City Planning, J. Tyler. *New Zealand Soc. Civ. Engrs.—Proc., 1931–1932*, vol. 18, 1932, pp. 334–355, 5 supp. plates. Development of city of Auckland, N.Z., since 1840; present population is about 230,000; review of city planning problems, with special reference to traffic problem.

CONCRETE

Columns, Concrete, Design. Das Bemessen der Saeulen nach den neuen Eisenbetonbestimmungen, Berrer. *Beton und Eisen*, vol. 31, no. 10, May 20, 1932, pp. 156–160. Design of reinforced-concrete columns in accordance with the new concrete specifications of the Reinforced Concrete Committee of Germany.

Construction, Cold Weather. Practical Pointers About Winter Building with Concrete, E. F. Rawcliffe. *Contract Rec.*, vol. 46, no. 44, Nov. 2, 1932, pp. 1233–1236. Recommended procedure for construction operations carried out during cold weather; principles of cold weather concreting; protecting fresh concrete.

Culverts, Concrete. Duration of Reinforced Concrete Railway Underbridges, J. D. W. Ball. *Engineer*, vol. 154, no. 4006, Oct. 21, 1932, pp. 400–401. Results of tests on culverts constructed for one of South American railroads; results of tests on beams loaded with rails and fish plates, 80 days after manufacture.

Design. Bending and Direct Compressions in Reinforced Concrete Sections, J. E. Jones. *Concrete and Constr. Eng.*, vol. 27, no. 10, Oct. 1932, pp. 565–573. Construction of graphical chart for determination of distance between neutral axis and compression surface of concrete section; determination of stresses; numerical example.

Hoover Dam Project, Concrete Construction. Ready-Mixed Concrete at Hoover Dam, W. B. Lenhart. *Rock Products*, vol. 35, no. 23, Nov. 19, 1932, pp. 40–45. Particulars of the largest and most modern concrete-mixing plant having four 4-yd Smith mixers; concrete is handled by a fleet of ten $4^1/_2$-yd Rex agitators mounted on White trucks; methods used in lining tunnels; materials-handling methods.

Mixing. Coordination of Basic Principles of Concrete Mixtures—VII, J. A. Kitts. *Concrete*, vol. 40, no. 11, Nov. 1932, pp. 17–19. Needed laws of mixtures and known fundamentals; strength variations; new equations of strength relations; effect of mixing, curing, and loading on strength; essential determination of fundamentals.

Roads and Streets. Concrete Roads in Belgium. *Concrete and Constr. Eng.*, vol. 27, no. 10, Oct. 1932, pp. 582–588. Review of modern practice in Belgium in construction of concrete roads; pre-cast concrete sets; surface-finishing plant; joints; curing of concrete.

Stresses. Elasticity and Hysteresis of Rocks and Artificial Stone, J. Gilchrist and R. H. Evans. *Engineering*, vol. 134, no. 3485, Oct. 28, 1932, pp. 519–522. Experiments begun in endeavor to obtain more definite data on stress-strain relations of concrete. Before Brit. Ass'n.

CONSTRUCTION INDUSTRY

Costs. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 7, no. 20, Oct. 25, 1932, pp. 618, 620, and 640. Unit costs bid on street and road work and bridges and culverts in California and Utah.

Estimating. Design Calculations for Estimating, W. S. Gray. *Concrete and Constr. Eng.*, vol. 27, no. 9, Sept. 1932, pp. 517–523. Collection of formulas for estimating quantities of

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INDUSTRIAL

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materials required in job; bending moment coefficients; allowances for continuity, laps, etc.; examples; estimate for flat-slab foundation; approximate checks on weight of steel.

DAMS

BALTIMORE. Baltimore Doubling Her Water Storage, R. G. Skerrett. *Compressed Air Mag.*, vol. 37, no. 10, Oct. 1932, pp. 3948–3951. Equipment and methods employed in excavating cut-off for the Prettyboy Dam on Gunpowder River.

CALIFORNIA. Current Dam Construction in Southern California, J. J. Ballard. *Eng. News-Rec.*, vol. 109, no. 19, Nov. 10, 1932, pp. 564–567. Features of rolled earth-fill dam at Bouquet Canyon, 215 ft high; concrete dam in Pine Canyon, 245 ft high; rock-fill dam San Gabriel No. 2, 255 ft high; and El Capitan hydraulic-fill dam 240 ft high.

CONCRETE GRAVITY, GREAT BRITAIN. Scar House Reservoir. *Concrete and Constr. Eng.*, vol. 27, no. 9, Sept. 1932, pp. 507–512. Construction of concrete gravity dam 154$^{1}/_{2}$ ft high and 1,825 ft long, for water supply of the city of Bradford.

EARTH, CALIFORNIA. Bouquet Canyon Earth-Fill Dam for Los Angeles Water Supply. *West. Construction News and Highways Bldr.*, vol. 7, no. 20, Oct. 25, 1932, pp. 599 and 600. Main features of draw having a height of 221.6 ft; width of crest 50 ft; length 1,200 ft; and slope of upstream and downstream faces 3:1.

HOOVER DAM PROJECT, RIVER DIVERSION. Preparing for River Diversion at Hoover Dam. *Eng. News-Rec.*, vol. 109, no. 21, Nov. 24, 1932, pp. 622–624. Account of work centered at the upper portals of the diversion tunnels; operations required to complete river diversion; temporary rock-fill dam built by dumping from trestle to turn river into diversion tunnel No. 4.

INDIA. Remarkable Progress of Mettur Dam Project—I and II, *Indian Eng.*, vol. 92, no. 13 and 14, Sept. 24, 1932, pp. 252–256 and Oct 1, pp. 272–274. Progress report on the construction of a concrete-gravity dam, over 165 ft high, for irrigation and hydro-electric power.

OUTLETS. Versuchlussvorrichtungen fuer Grundablaesse und Kraftrohrleitungen von massiven Talsperren, Theuerkauf. *Bautechnik*, vol. 10, no. 26, June 14, 1932, pp. 339–354. Design and construction of various types of sluices and valves for reservoir outlets, leading through gravity dams, also inlets of power conduits.

SPILLWAYS, EROSION. Combating Instability of Ground Structure at Arapuni, N. Z., R. W. Parkhurst. *Commonwealth Engr.*, vol. 20, no. 2, Sept. 1, 1932, pp. 39–42. Methods of preventing erosion in long-lined spillway channel of Arapuni Dam.

VALVE TOWERS. Construction of New Valve Tower and Outlet Pipe to Creggan Middle Reservoir, Londonderry, W. Criswell. *Water and Water Eng.*, vol. 34, no. 408, Sept. 20, 1932, pp. 447–450. Construction of lightly reinforced-concrete valve tower 30 ft. high, 4 ft. sq. inside dimensions.

FLOOD CONTROL

HUNGARY. Flood Control on Tisza River, J. Szilagy. *Military Engr.*, vol. 24, no. 138, Nov.–Dec. 1932, pp. 623–626. Hydrology of Tisza River, with special reference to flood records; description of and comments on flood control system of river; profiles of Tisza before and after shortening.

LEVEE CONSTRUCTION. Levee Building with Tower Machine and Crawler Wagons. *Contractors and Engrs. Monthly*, vol. 25, no. 5, Nov. 1932, pp. 21–23. Methods used in the construction of 7 miles of new levee near Lake Village, Ark., involving a handling of 2,800,000 yd at $12.90 per yard.

TEXAS. High September Floods Along Rio Grande, L. M. Lawson. *Eng. News-Rec.*, vol. 109, no. 19, Nov. 10, 1932, p. 557. Data on Sept. 1932 flood conditions on the Rio Grande between Presidio and Rio Grande City, a distance of about 680 miles; gage heights and estimated discharges.

FOUNDATIONS

BEARING POWER. New Pile-Bearing Formula from Model-Pile Tests, L. C. Wilcoxen. *Eng. News-Rec.*, vol. 109, no. 18, Nov. 3, 1932, pp. 524–526. Results of tests with home-made apparatus; resistance of piles of several shapes pressed into sand and clay; behavior of piles when driven by impact; from results of impact tests new pile-bearing formula is determined.

CAISSONS, CONCRETE, CONSTRUCTION. Concrete Lagging Used for Deep-Well Caissons. *Eng. News-Rec.*, vol. 109, no. 19, Nov. 10, 1932, p. 563. Use of T-shaped concrete lagging in construction of caissons for the column foundation of the Field Building, in Chicago; lagging becomes part of finished pier when excavation is filled with concrete.

EARTH PRESSURE. Lateral Pressure of Earth, A. G. Park. *New Zealand Soc. Civ. Engrs.—Proc. 1931–1932*, vol. 18, 1932, pp. 357–381. Compilation reviewing earth-pressure theories to present day, with particular reference to study by J. Feld. Bibliography.

PILES, CONCRETE. Thirty-Three Miles of Precast Piling, H. H. Hughes. *Concrete Products*, vol. 41, no. 10, Oct. 1932, pp. 10 and 11. New system of manufacture of pre-cast concrete piles used in Washington, D.C.; forms and tables, yard layout, and complete method of manufacture; during peak production a total of from 150 to 190 piles was poured daily.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

FOUNDATIONS, EARTHQUAKE EFFECT. Experimental Study of Seismic Earth Pressure, H. Matsuo. *Civ. Eng. Soc. Japan—Journal*, vol. 17, no. 8, Aug. 1932, pp. 825–844. Original study, including observations on deformation of soil strata. (In Japanese.)

RAIN AND RAINFALL. Comparison of Methods for Determining Areal Mean Precipitation on Drainage Areas, J. B. Belknap. *New England Water Works Ass'n—Journal*, vol. 46, no. 3, Sept. 1932, pp. 272–282. Results of comparison of methods applied to each of three well-gaged watersheds in Massachusetts, rainfall figures for 1930 being used; variation in results is not enough to justify additional work incident to use of Thiessen method, although it may be theoretically more correct.

INLAND WATERWAYS

CANAL LOCKS, EGYPT. Construction of Regulator and Lock at Kafr Bulin, F. W. C. Roberts. *Inst. Civ. Engrs.—Selected Eng. Papers*, no. 104, 1931, 14 pp., 1 supp. plate. Design, construction, and costs of brick and concrete block canal regulator and 12-m lock on large Egyptian irrigation canal; detail of regulating steel gates and of lock gates having a total span of 12 m and able to withstand a depth of water of 5 m.

IRRIGATION

CHINA. Wei Pei Irrigation Project, O. J. Todd. *Ass'n Chinese and Am. Engrs.—Journal*, vol. 13, no. 5, Sept. 1932, pp. 1–16. History of irrigation on Wei Pei plain; modernization of irrigation system, including construction of low concrete diversion weir 250 ft long, across the King River, tunnel 1,300 ft long in difficult rock, and open-cut canal 3.85 miles long; total cost is about $250,000. (In English.)

WEIRS, AUSTRALIA. Location, Design, and Construction of Weirs in New South Wales, G. Huddleston. *Inst. Engrs. Australia—Journal*, vol. 4, no. 9, Sept. 1932, pp. 308–316. Problems which have arisen in the location, design, and construction of weirs; description of various types of weirs in use in New South Wales, and instances of a few failures; river conditions in New South Wales.

LAND RECLAMATION AND DRAINAGE

NETHERLANDS. Enclosure of Zuyder Zee, B. Cunningham. *Engineering*, vol. 134, no. 3487, Nov. 11, 1932, pp. 553 and 554. Completion of actual process of enclosure by the cutting off of all free connection between inner and outer waters; work was carried out in a series of stages; although enclosure has been definitely realized, much more work remains to be done before dike can be brought to condition of finished embankment.

MATERIALS TESTING

CONCRETE TESTING, ABSORPTION. Accelerated Absorption Tests on Concrete. *Eng. News-Rec.*, vol. 109, no. 18, Nov. 3, 1932, p. 521. Usual absorption-test method accelerated by means of immersing standard compression-test cylinder in specially designed tank filled with water and by creating pressure of 200 lb per sq in. during test period.

ROAD MATERIALS, EMULSIONS. Improvement in Distillation Test for Emulsions, G. Abson and R. M. Heine. *Roads and Streets*, vol. 75, no. 11, Nov. 1932, p. 456. Outline of simplified test eliminating trouble from foaming.

PORTS AND MARITIME STRUCTURES

HYDRAULIC GATES, GERMANY. Das Sperrtor am Marientor in Duisburg, K. Hoening. *Bauingenieur*, vol. 13, no. 19–20, May 6, 1932, pp. 253–257. Design and construction of new Marientor pontoon sluice gates, with span of 16 m, in river port of Duisburg; details of operating mechanism.

LIVERPOOL. Development of Port of Liverpool. *Naut. Gaz.*, vol. 122, no. 22, Oct. 29, 1932, pp. 5–11 and 31. Great center of world trade, with shipping services extending to all parts of the globe; group of regular shipping services which cater to over-sea trade listed; second largest milling center in world; principal products imported; early port history; first commercial dock in England; northern extension works.

LONDON. Port of London. *Naut. Gaz.*, vol. 122, no. 23, Nov. 12, 1932, pp. 7–10 and 26–27. Facts concerning vastness; port includes whole of tidal portion of River Thames; details of each of its five large docks systems; Tilbury passenger-landing stage; drydocks.

PUERTO RICO. Port Problem in Puerto Rico, C. T. Leeds. *Military Engr.*, vol. 24, no. 136, July–Aug., 1932, pp. 390–395. Report on Port Ponce; failure of recently constructed bulkhead and wharf; fundamental study of port development; exposure of harbor; possible shoaling of harbor; failure of bulkhead wharf; investigation and tests; repairs and reconstruction.

SAN JUAN, PUERTO RICO. Informe de la mejoras de Rios y Puertos en el Distrito de Puerto Rico, R. T. Ward. *Revista de Obras Publicas de Puerto Rico*, vol. 9, no. 5, May 1932, pp. 89–91. Report on the improvement of rivers and ports in the district of Puerto Rico; port of San Juan; descriptive notes; historical data; project for dredging channel 30 ft. deep and 600 ft. wide.

UNITED STATES. Ports of Olympia and Port Angeles, Wash. *U.S. Army and U.S. Shipg. Bd.—Port Series*, no. 23, 1932, p. 8 and supp. pp. Port and harbor conditions; port customs and regulations; port services and charges; fuel and supplies; port and harbor facilities; communications; commerce of port.

SOUTHAMPTON. Evolution of Port of Southampton. *Naut. Gaz.*, vol. 122, no. 21, Oct. 15, 1932, pp. 5–8 and 26. Historical review; diagram showing increased facilities under construction; favorable location; traffic; natural advantages; Empress dock; cargo handling; passenger traffic.

TORONTO, ONT. Water-Borne Trade of Toronto Harbor, J. G. Langton. *Eng. Journal*, vol. 15, no. 11, Nov. 1932, pp. 522 and 523. Statistics regarding development and growth of traffic in Toronto Harbor, particularly the effect of the Welland Ship Canal, when opened in 1931 to 18-ft navigation.

ROADS AND STREETS

BITUMINOUS. Properties of Bituminous Emulsions for Paving Purposes in Japan, E. Nishikawa. *Civ. Eng. Soc. Japan—Journal*, vol. 17, no. 8, Aug. 1932, pp. 857–874. Chemical analysis and physical properties of asphalt and other bituminous materials. (In Japanese.)

BRICK, PAVING, SPECIFICATIONS. Die Strassenklinker-Normung marschiert. *Tonindustrie-Ztg.*, vol. 56, no. 78, Sept. 26, 1932, pp. 968–971. Progress in vitrified-paving-brick standardization; size and shape of brick; water permeability; frost resistance; compressive strength and cracking resistance; mechanical wear; tentative rules for acceptance and testing of paving brick.

CONCRETE. Economies in Modern Cement Concrete Highways, J. M. Breen. *Contract. Rec.*, vol. 46, no. 38 and 39, Sept. 21, 1932, pp. 1067 and 1068 and Sept. 28, pp. 1129 and 1130. Sept. 21: Initial and final costs; factors involved in cost; construction costs. Sept. 28: Durability; salvage valve; maintenance costs. (To be continued.)

CONSTRUCTION. Hand Labor Not Extravagant on Michigan Roads, C. M. Ziegler. *Eng. News-Rec.*, vol. 109, no. 19, Nov. 10, 1932, pp. 561 and 562. Methods and cost analysis of $12,000,000 road-work program of the winter of 1931–1932 for unemployment relief, carried out by the Michigan Highway Department.

GRADE SEPARATION. Overpass Aids Traffic in Washington, D.C., Park, D. H. Gillette. *Eng. News-Rec.*, vol. 109, no. 13, Sept. 29, 1932, pp. 380 and 381. Description of three-span continuous T-beam structure with cellular abutments, on circular cylinders and buttress piers, built in Rock Creek Park.

GREAT BRITAIN. Developments in Road Paving. *Quarry and Roadmaking*, vol. 37, no. 427, Aug. 1932, pp. 342–345. Metropolitan street paving; total mileage; mileage or area of different kinds of street surfacing and total annual cost of improvement works and maintenance (1931–1932). (Concluded.)

GUTTERS. Brick for Gutters and Parking Strips. *Pub. Works*, vol. 63, no. 9, Sept. 1932, p. 26. Advantages of this type of street construction and approved methods of laying it.

LOW-COST. Road-Mix Types Low-Cost Roads. *Pub. Works*, vol. 63, no. 9, Sept. 1932, pp. 15–19. Symposium consisting of two papers: Building Macadam-Aggregate or Retread Type, G. E. Martin; and Construction Details of Graded Aggregate Type, B. E. Gray.

LIGHTING. Highway Lighting, F. Gunnison. *Elec. Journal*, vol. 29, no. 10, Oct. 1932, pp. 462 and 463. Highway lighting and its relation to accidents and crime; statistical data; example of uniform highway lighting is illustrated; reflecting surfaces and obstacles likely to cast shadows have been recognized as part of lighting problem, and illumination has been directed on right-of-way accordingly.

MACADAM. Bituminized-Cement Macadam Road Experiments. *Eng. News-Rec.*, vol. 109, no. 14, Oct. 6, 1932, p. 400. Construction of test roads in the United States and more than 200 miles of European roads resurfaced with stone penetrated with mortar of bitumen-impregnated cement, indicating new road type possibilities; field observations and laboratory tests.

MAINTENANCE AND REPAIR. Safe Type of Winter Road, G. Hemmerick. *Contract. Rec.*, vol. 46, no. 44, Nov. 2, 1932, pp. 1251–1253

INDEX TO ADVERTISERS

INDUSTRIAL

The Society reserves the privilege of rejecting advertisements inconsistent with its ethical procedure.

Alphabetical Index to Advertisers Shown on Page 18

Method of conditioning slippery surfaces with sand treated with chloride; sand-casting device; snow fence manufacture at St. Mary's.

Night Construction. Building Highways at Night, H. E. Mahan. *Roads and Streets*, vol. 75, no. 11, Nov. 1932, pp. 459 and 460. Classification of road construction operations; lighting requirements of highway construction; power requirements.

Railroad Crossings, Signals and Signaling. Level Crossing Protection in Argentina. *Ry. Gaz.*, vol. 57, no. 17, Oct. 21, 1932, pp. 485 and 486. Short track circuits successfully used on Entre Rios Railway, instead of mechanical contact apparatus; wiring diagram.

Snow Removal. Snow-Removal Equipment Is Tested During Summer Months, W. M. Hanson. *Can. Engr.*, vol. 63, no. 19, Nov. 8, 1932, pp. 24 and 25. Four Wheel Drive Auto Company drives truck headlong into clay bank more than twelve hundred times, in order to secure design data.

SEWERAGE AND SEWAGE DISPOSAL

Activated Sludge. Activated Sludge Practice, P. B. Streander. *Sewage Works Journal*, vol. 4, no. 5, Sept. 1932, pp. 865–878 (discussion) 878–880. Types of agitators and aerators for aeration tanks; design features and general data; present status of process; Before Pennsylvania Sewage Works Ass'n.

Analysis. Rapid Moisture Determination of Sewage Sludge, H. Weiner. *Sewage Works Journal*, vol. 4, no. 5, Sept. 1932, pp. 795–799. Apparatus and materials; procedure; moisture in sewage sludge as determined by quantity of filtrate obtained from vacuum filtration.

Belt Conveyors. Belt Concreting at Ward's Island. *Eng. News-Rec.*, vol. 109, no. 18, Nov. 3, 1932, pp. 517–521. On new 180-mgd sewage plant at New York, combination of fixed and portable belt-conveyor units has distributed 108,000 cu yd of concrete over an area of 30 acres; heavy wall-form panels moved by special handling rig on truck; handling reinforcing steel; pre-cast concrete work.

Design. Function of Each Unit of Sewage Plant, I. S. Walker. *Sewage Works Journal*, vol. 4, no. 5, Sept. 1932, pp. 834–845. Review of up-to-date practice, including American, British, and Russian experience. Before Pa. Sewage Works Assn.

Gas Recovery. Floating Sludge Reduces Digestion-Tank Gas Yield, H. W. Taylor. *Eng. News-Rec.*, vol. 109, no. 13, Sept. 29, 1932, pp. 372 and 373. During cold weather floating material remains cold and inactive despite tank heating; excessive tank temperatures appear to retard gas production; notes on operation of new sewage plant at Rome, N.Y.; tests on sludge concentration.

Great Britain. Birmingham, Tame, and Rea District Drainage. *Surveyor*, vol. 82, no. 2128, Nov. 4, 1932, pp. 399 and 400. New construction and results of operation of plant serving a population of 1,133,000; sewage treatment and disposal; sludge gas plant operation; economy in working; waste heat recovery plant; prevention of smell nuisance on disposal plants.

Infiltration. Remodeling Lancaster, N.Y., Sewage Treatment Works, H. J. Huber. *Sewage Works Journal*, vol. 4, no. 5, Sept. 1932, pp. 821–833. Elimination of excessive ground-water infiltration into sanitary sewer system. Before New York State Sewage Works Ass'n.

Japan. Sewerage of Tokyo City, J. Takahashi. *Civ. Eng. Soc., Japan—Journal*, vol. 17, no. 8, Aug. 1932, pp. 807–824. Plan of system, sewage analyses, and methods of sewage treatment. (In Japanese.)

Operation. Hourly Variation of Indianapolis Sewage, C. K. Calbert. *Sewage Works Journal*, vol. 4, no. 5, Sept. 1932, pp. 815–820. Analysis of samples of raw and treated sewage taken to correspond with hours indicated; chloride variation at river stations.

Sewers, Design. One-Pipe System of Drainage, W. H. Draper. *Surveyor*, vol. 82, no. 2126, Oct. 21, 1932, pp. 353 and 354 (discussion) 354. Extract from paper read at a meeting of the Royal Sanitary Institute; nuisance from present British system; choice of materials for pipes; suggested additions to by-laws.

Sludge. Enzymes and Sludge Digestion, W. Rudolfs. *Sewage Works Journal*, vol. 4, no. 5, Sept. 1932, pp. 782–789. New Jersey Experiment Station studies on the effect of several enzymes upon the digestion of fresh solids, fine screenings, and activated sludge; results show very little difference in regard to digestion time, gas production, material handled, drainability, and odors, between materials to which enzymes were added and those digested without enzymes. Bibliography.

Stream Pollution. Sanitary Conservation of Streams by Cooperation, W. L. Stevenson. *Am. Inst. Chem. Engrs.—Trans.*, vol. 27, 1931, pp. 9–30. Different kinds of cooperation with some instances showing results attained; admission of industrial wastes to public sewers; cooperative sewerage projects; cooperation between state and municipalities toward sewage treatment; cooperation of state and industry; interstate stream agreements.

Tanks. Location of Septic Tanks and Disposal Areas for Rural Jobs, W. A. Hardenbergh. *Domestic Eng.* (*Chicago*), vol. 140, no. 4, Sept. 1932, pp. 52 and 53. Summary of answers to questionnaire sent to experienced sanitary engineers of New York and Northern New England; examination of site; conditions to be observed; how septic tank troubles occur.

STRUCTURAL ENGINEERING

Arches, Design. Simplification of Arch Design, G. H. Hargreaves. *Concrete and Constr. Eng.*, vol. 27, no. 9, Sept. 1932, pp. 497–505. Live load; rib shortening; temperature and shrinkage; summary of results; alteration of design. (Concluded.)

Beams, Concrete. Estimating Constants for Concrete Beams, W. S. Wilson. *Civ. Eng.* (*Lond.*), vol. 26, no. 315, Sept. 1932, pp. 10, 11, and 13. Volume of concrete; weight of steel per foot run.

Columns, Stresses. Column Curves and Stress-Strain Diagrams, W. R. Osgood. *U.S. Bur. Standards—Journal Research*, vol. 9, no. 4, Oct. 1932, pp. 571–582. Comparative study of a few of the commonest types of empirical formulas and a determination of the shape of the stress-strain diagram in each case, which makes them compatible with Considère-Engesser theory.

Domes, Design. Unique Dome Design Fixed by Need for Light Members, J. Lasker. *Eng. News-Rec.*, vol. 109, no. 13, Sept. 29, 1932, pp. 375 and 376. Design of hexagonal dome 80 ft in diameter with surface of alternate ridges and valleys for the auditorium of the Rosenbloom Building of the Hebrew University of Jerusalem; dome and supports are of steel, entirely separate from rest of building as precaution against earthquakes; earthquake hazards dictate the use of steel framing; lack of unloading facilities and erection equipment limits permissible size of members.

Walls, Straightening. Straightening Leaning Building Walls by Jacking Frames, E. H. Krautheim. *Eng. News-Rec.*, vol. 109, no. 13, Sept. 29, 1932, p. 382. Construction of steel frames serving as buttresses for twelve 35-ton screw jacks; cost was less than 5 per cent of estimated cost of replacing walls.

TUNNELS

British Columbia. Steel and Concrete Water Supply Tunnel in Vancouver. *Iron and Steel of Canada*, vol. 15, no. 10, Oct. 1932, pp. 126 and 127. Description of the water-supply tunnel 3,100 ft long, with two shafts 400 ft deep, under the Burrard Inlet, Vancouver; lower part of shafts 8 ft in diameter and tunnel 7$^1/_2$ ft in diameter are lined with steel cylinder reinforced concrete pressure pipe, shop-built in sections and joined into monolithic structure in place.

Pedestrian, California. Pedestrian Tunnels Provide Jobs for San Diego Unemployed, T. E. Kenny. *Eng. News-Rec.*, vol. 109, no. 17, Oct. 27, 1932, p. 490. Construction of four pedestrian tunnels, principally for the safety of school children, up to 270 ft in length, with a standard interior section, 6 ft wide and 7 ft high.

Railroad, Concrete Roadbeds. Investigation of Concrete Bed in Shimizu Tunnel, I. Horikoshi. *Japanese Gov. Ry.—Bul.*, vol. 20, no. 29, Aug. 25, 1932, 14 pp. Study to obtain data on the design and construction of concrete bed; various conditions of permanent way taken into consideration; investigation carried out after the tunnel had been used for ordinary train working; vibration of vehicles; noise caused by running trains; conditions of track and cost of track maintenance. (In Japanese.)

Surface Treatment. Steel-Armored Subway Pavement, C. D. Crowe. *Can. Engr.*, vol. 63, no. 14, Oct. 4, 1932, pp. 15 and 19. Roadway surfaces at Wellington Street Tunnel, Montreal, protected by continuous open-steel armoring.

Water Supply Tunnels, New York City. New Water Supply Tunnel for New York City. *Engineer*, vol. 154, no. 4004, 4005, and 4006, Oct. 7, 1932, pp. 346 and 347; Oct. 14, pp. 374 and 375; and Oct. 21, pp. 398–400, and 408; supp. plates. Said to be the longest continuous tunnel in the world. City Tunnel No. 2 has a total length of 20 miles and the generally prevailing diameter is 17 ft inside concrete lining; to provide a new means of delivering water primarily to the boroughs of Bronx, Queens, and Brooklyn; the tunnel was driven from 19 shafts; shaft sinking; mucking, blasting, and concreting.

WATER PUMPING PLANTS

Great Britain. Surbiton Water Works. *Engineer*, vol. 154, no. 4007 and 4008, Oct. 28, 1932, pp. 428 and 429; and Nov. 4, pp. 452–455 and 458. Main portion of the new machinery consists of four steam turbines, taking steam at 250 lb per sq in. pressure and a total temperature of 600 F; each booster pump is driven through coupling on a main shaft; each unit capable of pumping to any district; pumps and turbines; boiler installation; coal handling.

WATER RESOURCES

Japan. River-Discharge of Japan, H. Kikuchi. *Civ. Eng. Soc., Japan—Journal*, vol. 17, no. 8, Aug. 1932, pp. 919–938. Characteristics of the principal watersheds of Japan; discharge records and hydrographs of principal streams. (In Japanese.)

WATER TREATMENT

Activated Carbon. Powdered Activated Carbon in Water Purification, F. E. Stuart. *New England Water Works Ass'n—Journal*, vol. 46, no. 3, Sept. 1932, pp. 312–315. History of carbon in water purification; rôle of powdered activated carbon in water purification; methods and technic of powdered carbon application; carbon dosage.

Asia. Purification of Public Water Supplies in the Orient, J. D. Edal Behram. *Water Works and Sewerage*, vol. 79, no. 10, Oct. 1932, pp. 333–337. Information gathered during travel through the Orient and experiences as a chemist and bacteriologist at the Shanghai Water Works in China; water supply of small towns and villages; water supplies of Japan; intakes; coagulants and their application; settlement; filtration; semi-rapid filtration; rapid filtration; double filtration; chlorination.

Turbidity. Observations on Coagulation Methods Applied in Treatment of Highly Turbid Water, H. A. Hartung. *Water Works Eng.*, vol. 85, no. 22, Nov. 2, 1932, pp. 1310–1313. Experience of the St. Louis Water Company; lime treatment of river water with a low total of alkalinities has an entirely different reaction upon water than when the total alkalinities are well above 100 ppm; coagulation with ferrous sulfate and aluminum sulfate; secondary coagulation; coagulating 17,000 ppm of turbidity.

Water Chlorination, Hypochlorite. Where Dry Hypochlorites Pay in Water-Works Practice, J. A. Kienle. *Water Works and Sewerage*, vol. 79, no. 10, Oct. 1932, pp. 359–361. Use of calcium hypochlorite for sterilization and cleansing of filter sand; algae and bacterial after-growths; continuous or intermittent use.

Water Filtration Plants, Indiana. Peru, Ind., Builds Filter Plant with Water and Light Plant Earnings, C. Brossman. *Pub. Works*, vol. 63, no. 11, Nov. 1932, pp. 14–16. Features of new filtration and deferization plant of Peru, Ind., which has a population of 12,000; cost $160,000.

WATER WORKS ENGINEERING

Aqueducts, Colorado River. Colorado River, Aqueduct for Bringing Water to Southern California, E. E. Thomas. *Gen. Elec. Rev.*, vol. 35, no. 11, Nov. 1932, pp. 554–559. Features of the project described in several previously indexed articles; choice and location of aqueduct; Parker Route; Parker Dam; pumping plants; distribution system; generating plants; transmission line; construction material required; financial summary; comparison with Hoover Dam.

Arizona. Phoenix Water System Improvements, C. C. Kennedy and W. J. Jamieson. *West. Construction News and Highways Bldr.*, vol. 7, no. 20, Oct. 25, 1932, pp. 591–599. Construction of protective works for infiltration gallery and well field; 30-mgd low and high-pressure supply line; large sand-removal tank or detritor; control house; and 20-mgd circular earth-embankment reservoir; concrete pipe manufacture and tests; Hume steel-cylinder pipe tests.

Mexico. Algunos Datos Relativos al Abastecimiento de Aguas de Morelia, R. M. Gutierrez. *Revista de Ingenieria y Arquitectura*, vol. 10, no. 10, Oct. 1932, pp. 416–424. Notes on the water supply system of the city of Morelia.

United States. Regional Water Problems at N.E.W.W. Meeting. *Eng. News-Rec.*, vol. 109, no. 14, Oct. 6, 1932, pp. 412 and 413. Proceedings of the 51st annual convention of the New England Water Works Ass'n, including abstracts of papers on Springfield water supply, power from Cobble Mountain dam, impounded supplies, manganese in reservoir water, water distribution, new water-treatment practices.

Water Towers, Great Britain. Water Tower at Caister-on-Sea. *Concrete and Constr. Eng.*, vol. 27, no. 10, Oct. 1932, pp. 574–581. Construction of one of the largest reinforced-concrete water towers in Great Britain; shaft of tower has an internal diameter of 52 ft; section of shaft is regular dodecagon, and its height is 113 ft; water tank is divided into two annular portions by circumferential wall and has a capacity of 784,000 gal; domed roof is 79 ft in diameter and 6 in. thick, with a 6-ft central opening surrounded by a monolithic concrete curb 6 in. wide.

Wells, Maintenance and Repair. Certain Types of Well Screens May be Freed of Incrustation by Acid Treatment for Wells, H. O. Williams. *Water Works Eng.*, vol. 85, no. 19, Sept. 21, 1932, pp. 1132–1134. Procedure for single and double acid treatment; use of compressed air; use of dry ice; acid treatment when removing screens. Before Am. Ass'n. Water Well drillers.

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ALPHABETICAL

Industrial Index to Advertisers shown on pages 14 and 16